DOCUMENT RESUME

ED 139 598 SE 021 307

AUTHOR	Caulfield, Henry P., Jr., Ed.; And Others
TITLE	Manual for Training in the Application of the Principles and Standards of the Water Resources Council.
INSTITUTION	Colorado State Univ., Ft. Collins. Environmental Resources Center.
SPONS AGENCY	Department of the Interior, Washington, D.C. Office of Water Research and Technology.
BUREAU NO	C-5345; X-143
PUB DATE	Dec 74
GRANT	14-31-0001-4242; 14-31-0001-4260
NOTE	586p.; For related document, see SE 021 308 ; Tables and legends for some figures may be marginally legible due to small print of the original document
EDRS PRICE	MF-$1.16 HC-$31.47 Plus Postage.
DESCRIPTORS	*Educational Programs; *Government Employees; *Instructional Materials; Manpower Development; *Post Secondary Education; *Training; *Water Resources

ABSTRACT

This manual is one of four planned outputs of a training project conducted by the Environmental Resources Center of Colorado State University with the cooperation of the Water Resources Council. The purpose of this manual, together with the videotapes of lectures given during the project, is to provide materials for the conducting of similar training courses by others throughout the country. Academic experts, top officials of the Water Resources Council, planning experts and research personnel were obtained to impart intellectual understanding and policy indoctrination concerning the Principles and Standards; understanding of specific criteria and knowledge needed to apply them in the world of planning; and knowledge of new technologies. The lectures/papers of the instructors on such topics as Environmental Quality Objectives, Environmental Projections, Measurement, Systems Analysis, Public Participation and Plan Formulation, are included. A list of the 25 video tape cassettes developed by the project and the project instructors concludes this manual. (BT)

Documents acquired by ERIC include many informal unpublished materials not available from other sources. ERIC makes every effort to obtain the best copy available. Nevertheless, items of marginal reproducibility are often encountered and this affects the quality of the microfiche and hardcopy reproductions ERIC makes available via the ERIC Document Reproduction Service (EDRS). EDRS is not responsible for the quality of the original document. Reproductions supplied by EDRS are the best that can be made from the original.

Technical Report Series #7

ED139598

Colorado State University
in cooperation with the
U.S. Water Resources Council
and the
Office of Water Research and Technology
U.S. Department of the Interior

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Manual for Training in the Application of Principles and Standards

Water Resources Council

SE 021 307

MANUAL FOR TRAINING

IN THE

APPLICATION OF THE PRINCIPLES AND STANDARDS

OF THE

WATER RESOURCES COUNCIL

Edited By

Henry P. Caulfield, Jr.

Harry A. Steele

Sam H. Johnson III

Environmental Resources Center
Colorado State University
December 1974

The preparation and publication of this document was supported in part with funds provided by the U.S. Department of the Interior, Office of Water Research and Technology under P.L. 88-379, Grant No. 14-31-0001-4260, Project X-143, and Grant No. 14-31-0001-4242, Project C-5345.

TABLE OF CONTENTS

Lecture/Papers for Training in the Application of Principles and Standards of the Water Resources Council

Broad Topic Groupings	Training Manual	WRC[1] Cassette No.	Subject Title	Author/Lecturer[2]	Page
			Introduction	Henry P. Caulfield, Jr.	iii
I. Overview	TM 1	WRC-1	Overview of Principles and Standards	Warren D. Fairchild, Water Resources Council	1
	TM 2	WRC-2	Planning Process and Its Institutional Setting	Gary D. Cobb, Water Resources Council	12
II. Objectives	TM 3	WRC-3	National Economic Development (NED) Objective	Robert A. Young, Colorado State University	31
	TM 4	WRC-4	Environmental Quality (EQ) Objective	Ervin H. Zube, University of Massachusetts	50
	TM 5	WRC-5	Regional Development (RD) and Social Well-Being (SWB)	Robert M. Gidez, INTASA Consultants, Alexandria, VA	67
	TM 6	WRC-6	Economic Projections	Henry L. DeGraff, Bur. Econ. Analysis, U.S.D.C. William A. Green, Econ. Research Service, U.S.D.A.	83
III. Projections	TM 7	WRC-7	Environmental Projections and Carrying Capacity Models	A. Bruce Bishop, Utah State University	109
IV. Measurement	TM 8	WRC-8	Measurement of NED Effects	Robert A. Young, Colorado State University	136
	TM 9 & 10	WRC-9	Measurement of EQ Effects (Part A)	Gary L. Hickman, Fish & Wildlife Service, Dept. of Interior	150
		WRC-10	Measurement of EQ Effects (Part B)	Gary L. Hickman, Fish & Wildlife Service, Dept. of Interior	
	TM 11a	WRC-11	a) Overall Issues and Methods of Measurement	Dirk P. Lijesen, INTASA Consultants, Menlo Park, CA and	221
	TM 11b		b) Economic Models for the Measurement of Regional Income and Employment Effects	Henry L. DeGraff, Bur. Econ. Analysis, U.S.D.C.	252
	TM 12	WRC-12	Measurement of SWB Effects	Dirk P. Lijesen, INTASA Consultants, Menlo Park, CA	267
V. Systems Analysis	TM 13	WRC-13	Application of Systems Analysis to the Planning Process	John W. Labadie, Colorado State University	309
	TM 14	WRC-14	System of Accounts and Cost Allocation	Gary D. Cobb, Water Resources Council	327
	TM 15	WRC-15	River Basin Simulation for Planning	Robert W. Hill, Utah State University	351
VI. Public Participation	TM 16	WRC-16	Analysis of Tradeoffs	John E. Keith, Utah State University	372
	TM 17	WRC-17	Determination of Political Feasibility	James Mulder, Utah State University	393
	TM 18	WRC-18	Public Participation	Ann Widditsch, Public Affairs Consultant, Seattle, WA	422
	TM 19	WRC-19	Public Decisionmaking Processes	Henry P. Caulfield, Jr., Colorado State University	442
VII. Plan Formulation	TM 20	WRC-20	Step 1-Specification of Components of NED and EQ Objectives	Leonard T. Crook, Great Lakes Basin Commission	455
	TM 21	WRC-21	Step 2-Evaluation of Resources Determination	George H. Wallen, U.S. Bureau of Reclamation	465
	TM 22	WRC-22	Step 3-Develop Alternative Plans	Don Jones, Soil Conservation Service, U.S.D.A.	472
	TM 23	WRC-23	Steps 4 and 5-Comparison of Alternative Plans	Don Jones, Soil Conservation Service, U.S.D.A.	480
	TM 24	WRC-24	Step 6-Selection of a Recommended Plan	Emil W. Adam, Corps of Engineers, San Francisco	482
VIII. Conclusions	TM 25	WRC-25	"Windup"	Warren D. Fairchild, Water Resources Council	503
			Appendix 1		513
			Appendix 2		514

---

[1] See Appendix 1 for WRC Cassettes Available for Training in Conjunction with Manual.

[2] See Appendix 2 for Author's Titles and Addresses.

INTRODUCTION

This Manual for Training in the Application of the Principles and Standards for Planning Water and Related Land Resources of the Water Resources Council[1] is one of four planned outputs of a training project entitled: Transfer of Technology--Training of Government Personnel in the Application of the Principles, Standards and Procedures for Planning of the Water Resources Council (OWRT Grant No. 14-31-0001-4242, Project C-5345). The three other planned outputs are:

(1) Training of Participants: Forty-seven (47) trainees and thirty-three (33) observers attended a ten-day training course at Colorado State University from August 12-23, 1974. They were from all parts of the country and were affiliated with thirteen (13) Federal agencies, six (6) Federal-State river basin commissions, five (5) States and two (2) other river basin agencies.

(2) Color Video Tapes of Lectures: Twenty-five (25) cassettes, eight (8) to thirty-eight (38) minutes long, covering the main points made by lecturers to the participants at CSU, have been produced. These cassettes of 3/4 inch video tape are available by purchase or loan from the Water Resources Council, 2120 L Street, N.W., Washington, D.C. 20037.

(3) Evaluation Report on the CSU Training Course: This report, prepared by CSU's Human Factors Research Laboratory, has been published by the Environmental Resources Center, Colorado State University, December 1974. Copies are available upon request.

---

[1] See "Establishment of Principles and Standards for Planning Water and Related Land Resources", by the Water Resources Council (Federal Register, Volume 38, Number 174, Part III, September 10, 1973). Hereinafter, this document will be referred to as the Principles and Standards.

In addition to these four planned outputs, a by-product of the August training course was an identification of ambiguities, mistakes and other problems in interpreting the Principles and Standards. This information has been transmitted to the Director, Water Resources Council for use of the Council in its future work.

The purpose of this Manual, together with the video tapes of lectures, is to provide materials for the conduct of training courses by others throughout the country. The Evaluation Report on the CSU training course may also be useful in planning the future conduct of such courses.

The Principles and Standards relate directly only to Federal participation in planning the use of water and related land resources. Nevertheless, they are not just of concern to Federal agencies and Federal-State river basin commissions. State and local agencies, as well as private consulting firms, also need to understand their application to Federal and Federally-assisted projects. Further, they may want to apply them in other water and related land planning activities. In addition, universities and technical-institutes study their application to improve specialized training in the interdisciplinary aspects of water and related land use planning. Thus, given the entire spectrum of concern with their application, all of the above organizations should participate in widespread and intensive efforts to develop understanding of the application of the Principles and Standards.

No commitments were made that the participants at the CSU training course would become training directors or discussion leaders upon return to their respective agencies. Nevertheless, it is clear that they are a training resource to their agencies as well as a planning resource. This is so even though no training in the conduct of any further training efforts was included in the CSU course and no plan for such training is set forth in this Manual. Nevertheless, Colorado State University is interested in encouraging such further training. To the extent practicable and possible, the Environmental Resources Center, Colorado State University, will be glad to assist any organization in the planning, development and conduct of any future training programs.

To assist in the development of its plans for carrying out this training project, both with respect to the August training cource and the production of the video tapes and lectures, Colorado State University sought the views of an advisory committee composed of the following experts:

David Aggerholm
University of Massachusetts

David Allee
Cornell University

Warren Fairchild
Water Resources Council

Burnell Held
Colorado State University

Maynard Hufschmidt
University of North Carolina

Warren Hall
Office of Water Research & Technology

John Neuberger
Missouri River Basin Commission

Jack Pepper
State of Mississippi

Harry Schwarz
Clark University

Gilbert White
University of Colorado

Although the basic structure of plans and level of funding for carrying out this project was fixed by the time the advisory committee met in June 1974, many valuable suggestions were made and most of them were adopted. For these and other helpful contributions initiated by the advisory committee, grateful acknowledgment is made.

The views of members of the advisory committee varied somewhat on solutions to the main design of the training course, but their upshot was:

(a) to provide balance between imparting intellectual understanding and policy indoctrination concerning the Principles and Standards, understanding of specific criteria and knowledge needed to apply them in the real world of planning, and knowledge of new technologies believed to be useful in practical planning efforts; and

(b) balance between training through instruction and discussion and training through exercises involving thinking through applicational problems.

The balance of the first type, (a), was sought through the type of instructor that was recruited. Top officials of the Water Resources Council plus academic experts were obtained to impart policy indoctrination and intellectual understanding. Planning experts from government largely were recruited to cover points of specific criteria and knowledge needed for application and to lead the trainees in the conduct of the training exercises. Various applications of systems analysis utilizing computer technology were taken to be the most pertinent type of technology needing transfer from researchers to practitioners. Academic research personnel cognizant of practical affairs were obtained for the training in these applications. With regard to balance problem (b), time was divided almost equally in the ten-day course between training through instruction and training through exercises.

Trainee response to this balance of time, (b), as well as the balance, (a), between basic policy and intellectual understanding versus specific applicational knowledge, would appear to have been a function largely of a trainee's perception of his prior knowledge. Those who felt they knew little about the Principles and Standards responded most favorably to the instructional approach and to the lectures designed to impart basic policy and intellectual understanding. Those who believed themselves to be quite knowledgeable stressed the value of specific applicational knowledge and the training exercises. This distinction in a trainee's perception of his prior knowledge would appear to be important and should be taken into account in the development of plans for future training courses.[2] If practicable, separate training courses should be designed for each type of potential trainee.

Fundamentally, this training project in the application of the Principles and Standards was undertaken because a great gap has long been perceived to exist between "Washington" and university hopes and expectations from water and related land planning and its actual practice in the field. No overall inter-agency attempt to train in the application of prior principles, standards and procedures (e.g. Senate Document No. 97, Budget Bureau Circular A-47, or the Green Books) was ever attempted. This effort by Colorado State University, in cooperation with the Water Resources Council and the Office of Water Research and Technology, Department of the Interior, is thus a first effort. Much has been learned that would be helpful in planning any second effort. No doubt a second training project of this comprehensive type should be attempted some time in the future. In the meantime, it is to be hoped that the outputs of CSU's training project will be helpful in localized agency and commission training effort throughout the country.

---

[2] See "EVALUATION REPORT of the Training Program on Transfer of Technology--Training of Government Personnel in the Application of the Principles, Standards and Procedures for Planning of the Water Resources Council", Dr. Douglas Sjogren and Robert D. Wittman (Colorado State University, Environmental Resources Center, Fort Collins, Colorado. December 1974) pp. 1-2; 12-18.

When use is made of these materials, it should be recognized that the statements made in this Manual and on each video tape are those of the author/lecturer. It is possible that the views of the Water Resources Council are not always reflected. Although efforts have been made to avoid discrepancies, no systematic check has been undertaken. Discrepancies may exist and should be identified as use is made of these materials. Discrepancies that are believed to exist should be reported to the Water Resources Council, 2120 L Street, N.W., Washington, D.C. 20037.

What success has been achieved by CSU's 1974 training project is due to the efforts of many organizations and dedicated people for which gratitude should be expressed. First should be mentioned the trainees and observers who participated in the training course in August 1974 and the Federal, Federal-State, and State agencies that sent them. The interest and support of the participants and agencies was important indeed and is gratefully acknowledged. The critical comments of the participants and agencies will be most helpful in the planning of any further training programs.

Next, great thanks are due to the author/lecturers themselves and the governmental agencies which, in many cases, financially supported their participation. Special appreciation is due to Utah State University for assistance in project planning and making available several author/lecturers for participation -- particularly, to Dean F. Peterson, Vice President, and Daniel H. Hoggan, Associate Director, Utah Water Research Laboratory. For academic experts who are accustomed to speaking their own professional mind, the need to conform to the Principles and Standards presented an unaccustomed burden. For others, particularly the planning experts from government, the

problem of developing and then delivering a structured, succinct and interesting lecture was new. And for practically all author/lecturers, the requirements of televised presentation were unaccustomed and had to be quickly mastered. All gave of their best.

The entire staff of the Office of Educational Media, Colorado State University and its Director, Preston Davis, also deserve great thanks. The training project, as well as all of the author/lecturers are particularly in debt to the television producers, William D. Kruse, Larry Preuss, and Carlos Seegmiller, for their willing help, great skill and patience.

The final preparation and production of this Manual largely centered in the very capable professional hands of Maxwell Becker. I am particularly grateful to him and to Monica R. Clark, our secretary, for their patient and skillful efforts. Also, the excellent services of the Technical Typing Unit of CSU's Engineering Research Center, under the able direction of Arlene Nelson, are acknowledged.

Finally, I want to acknowledge my great personal debt to seven professional associates and friends without whose continuous support, advice and assistance the successful completion of CSU's training project would not have been possible. First, the support and advice of Warren Fairchild, Director, Water Resources Council and Warren Hall, Acting Director, Office of Water Research and Technology, Department of the Interior, is very gratefully acknowledged. Second, special credit should go to Jack C. Jorganson, Assistant Director--Technology Transfer, Office of Water Research and Technology, without whose initial inspiration and continuing interest the project would not have materialized; and to Stanley Ware, Chief, Engineering Systems Division, Office of Water Research and Technology, who officially monitored the project with great helpfulness and skill. Third, the continuous and very helpful efforts of Norman A. Evans, Director of CSU's Environmental Resources Center should be mentioned. Fourth, special thanks are due to Gary Cobb, Associate Director of the Water Resources Council. He not only provided necessary liaison with the Council staff and performed as an author/lecturer twice, but participated fully in planning the training project and in the consideration of the many issues that arose during the course of its progress.

Last, but far from least, I want to acknowledge my great indebtedness to Harry A. Steele and Sam H. Johnson, III. As consultant to the training project from beginning to end, Harry Steele brought to bear his incomparable knowledge, not only of the Principles and Standards, derived from his leadership and professional roles in bringing them to official adoption, but also his knowledge of the Nation's experience in water and related land resource planning derived from his distinguished career of over thirty years in the Federal government. Sam H. Johnson, III, graduate student and Ph.D. candidate in the Department of Economics, Colorado State University, served most ably, as my assistant during the most critical phases of the training project. Invaluable were his sharp insights, careful thinking through of problems to solution, his sense of responsibility, and his initiative and energy in seeing to it that everything needing doing was done.

Henry P. Caulfield, Jr.
Training Project Director

Fort Collins
December 31, 1974

OVERVIEW OF PRINCIPLES AND STANDARDS

Warren D. Fairchild
Director, Water Resources Council

The Principles and Standards for Planning Water and Related Land Resources were prepared pursuant to the Water Resources Planning Act of 1965 (P.L. 89-80) which established the Water Resources Council. This Act is the direct outgrowth of recommendations in a report of the Senate Select Committee on National Water Resources in January 1961.

Water Resources Council

The Water Resources Council is composed of the Secretaries of the Interior; Agriculture; Army; Health, Education and Welfare; Transportation; and the Chairman of the Federal Power Commission. Associate Members and Observers invited to serve on the Council include the Secretaries of Commerce; Housing and Urban Development; Administrator, Environmental Protection Agency; the Attorney General; Director, Office of Management and Budget; Chairman, Council on Environmental Quality; and the Chairmen of the eight river basin commissions (six established under Title II of P.L. 89-80) and the Delaware and Susquehanna River Basin Commissions. Presently, the Chairman of the Tennessee Valley Authority is being invited to serve as an Observer with consideration being given to inviting the Chairmen of the three existing Interagency Committees. As set forth in the Planning Act, the Council is to: (1) prepare a national assessment, (2) recommend water policies, (3) establish planning standards, (4) coordinate and manage comprehensive planning, (5) recommend river basin commissions, (6) review river basin plans, (7) assist State planning, and (8) other Executive Office assignments.

Over the course of the last year, the Members have taken a number of actions significantly affecting the operation of the Council. Among these include revision of the Council's Rules and Regulations on Council organization. The new organization rules and regulations will facilitate Council decision making and management by allowing greater participation by the alternates to the members; by delegating the Director more authority and responsibility with respect to the staff, and by giving the Council of Representatives and the Director more flexibility and authority with respect to the Council committee structure.

In addition, the Council has recently approved for the first time an explicit statement of procedures, policy, and objectives which is to guide and strengthen the development and implementation of the Council's programs, policies, and activities. More will be said on policy matters later in this presentation.

These two actions are mentioned because they significantly affect the Council's effectiveness in implementing, along with each of the Council's Member agencies, the Principles and Standards.

Planning Framework and Institutional Setting

Turn now for a moment to the planning work and institutional setting within which planning will be conducted within which the Principles and Standards are applied.

Levels of Planning

The Council, in Policy Statement #1 dated July 22, 1970, has defined three levels of planning: (a) framework studies and assessments, (b) regional or river basin plans, and (c) implementation studies.

Framework studies and assessments are merged into the first and broadest level of planning. This level of planning is characterized as dealing with the broadest level of choices to be made in the management of the Nation's natural resources. At this level of planning the choices are considered almost at a conceptual level dealing with major alternative policies and priorities.

For example, in this assessment consider the baseline projections based on series E projections and, in addition consider, variation from this baseline or central case scenario. These variations include: (1) increased agricultural exports; (2) increased irrigation efficiencies; (3) decreased oil imports; (4) increased flood regulations; (5) water price-demand sensitivity, and (6) changes in agricultural land-use and food and fiber production conditions. Thus, the assessment process will provide information about the effects of relative priorities on the component need of the two planning objectives--NED and EQ.

The regional or river basin level of planning, the next broadest level of planning, may be characterized as identifying major alternative management strategies for river basins. The level of study is to be undertaken for problems of such complexity that an intermediate step is needed between framework and implementation studies. The Council is evolving a new approach to Level B planning in an effort to make these studies timely, relevant, and of value to decision makers. This new approach has the following major characteristics:

1. Compact central management,
2. Two-year study periods,
3. Reduced costs by limiting development of new data and emphasizing judgmental planning.
4. Integrated water quantity and water quality considerations related to and coordinated with Federal and Federally assisted land planning programs (This was approved by the Members in the statement of Purpose, Policy and Objectives previously mentioned).
5. Planning processes covering alternative management strategies for institutional, legal, and other policy options as well as structural and nonstructural solutions to physical problems.
6. Providing minimal funding to States insuring State planning inputs.
7. Requiring a commitment of States to identify critical State issues and methods of resolution.

Implementation studies are the most detailed level of planning. They are program or project feasibility studies undertaken for the purpose of authorization or development of plan implementation. These studies are generally undertaken by a single Federal, State or local entity.

In addition, the Council has defined special studies which may be undertaken at any level of planning and may involve special problems related to data acquisition, single function studies, or other special studies that may by needed in carrying out any of the above levels of planning. Thus, there may be special studies required in each level of planning.

The Principles and Standards apply at all levels of planning. The key consideration in the application of the Principles and Standards in each level of planning relates to the manner in which the components of the objectives are specified. Obviously, at the broadest level of planning, the objectives are specified in a different way than they would be at the project level of planning. The objectives should be specified in each level of planning in such a manner that provides information and insights about the trade-offs among alternative choices.

The Principles and Standards were approved by the President and became effective on October 25, 1973. The Principles and Standards have evolved out of a long history of the desire of resource managers to develop an objective rationale and basis for natural resource programs.

History

Perhaps a little recap of water resources planning and development would be helpful here. The first funding by Congress for water resources development was of a military nature. On February 16, 1809, Congress provided for the improvement and extension of the Corondelet Canal for the purpose of facilitating the defenses of the City of New Orleans. In 1824 Congress enacted a general survey act with reference to routes for roads and canals of a national nature needed for commercial and military purposes and for mail delivery. In the same year, funds were appropriated for the removal of sand bars and trees in the bed of the Ohio River for the purpose of navigation.

As indicated above, the initial interests in water resources development was for navigation. Subsequent acts gradually incorporated other purposes. Key legislation that followed the 1824 acts include:

1. The Rivers and Harbors Act of March 3, 1899, which prohibited, unless a permit was issued, the deposition of refuse, dirt, mud, sand, etc. into any navigable waters of the United States or into any tributary.
2. The Reclamation Act of 1902, which authorized creation of the Bureau of Reclamation to provide irrigation water for economic development in arid areas.
3. The Weeks Law of March 1, 1911, which provided for the examination, survey, and acquirement of lands located on the headwaters of

navigable streams as were needed to regulate water flow. This Act provides a basis for the acquisition of National Forest lands.

4. In 1920 the Federal Water Power Act, through Section 10, prescribed the conditions surrounding the licenses authorized to be issued by the Federal Power Commission.
5. On April 27, 1935, P.L. 46, the Establishing and Enabling Act of the Soil Conservation Service, was approved.
6. The Flood Control Act of 1936 stated a policy for flood control and has since become broader due to the purposes..."that the Federal Government should improve or participate in the improvement of navigable waters or their tributaries including watersheds thereof, for flood control purposes if the benefits to whomsoever they accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected." This provision was the genesis of the benefit-cost analysis that has developed over the years. It should be pointed out that frequently, in referring to this Section, the last phrase is omitted.
7. On August 4, 1954, P.L. 566, the Watershed Protection and Flood Prevention Act was approved. This has become known as the small watershed program.

The first major effect defining a conceptual framework for consideration of market values was contained in a document commonly referred to as "the green book" first issued in 1950. It is believed most economists would agree that "the green book" was a landmark document in defining the conceptual framework for the economic efficiency objective. In 1952 the BOB issued Budget Circular No. A-47 which was an outgrowth of E.O. 9384 and was based on the Budget and Accounting Act of 1921. A-47 set forth the basis that would guide the BOB in evaluation and comparison of projects and the Bureau's review of reports. S.D. 97 was approved in 1964 and provided for rigorous application of economic concepts in plan formulation with adjustments for other considerations such as environmental, public health, and others.

More recently, new legislation reflecting changes in priorities and values including the Water Resources Planning Act of 1965 and the National Environmental Policy Act of 1969 forecast a need for further evaluation of planning policies. In 1968 the Council revised the discount rate formula to be used in establishing the discount rate for planning. The formula used prior to that data was based on the coupon rate of marketable securities which upon original issue had 15 years or more remaining to maturity. Under the formula established in 1968, the rate would be based upon the yield rate of marketable securities which have 15 years or more remaining to maturity at the time the rate is calculated during each successive year. Following revision of the discount rate, the Council initiated a four-year effort to evolve new planning Principles and Standards. Time will not be taken here to detail that effort except to say that it involved the work of a special task force; a series of revised documents; field tests; and three sets of separate public hearings over the course of the effort.

The Planning Process

The Principles and Standards recognize two coequal objectives in water planning: National Economic Development--that is, increased production of goods and services--and Environmental Quality--the enhancement of physical, ecological and aesthetic characteristics. In addition, careful consideration is given to beneficial and adverse effects on Regional Development and Social Well-Being. Accounting for environmental quality, national economic development, regional development, and social well-being gives planners, the affected public at large, Congress members and others an opportunity to evaluate fully the projected effects of a given plan or set of alternative plans.

Basically, planners must come up with at least two alternative plans--one maximizing the objective of increased national economic development, and the other maximizing environmental quality. Then, based on preferences expressed by the affected publics, a recommended plan is selected, either from one of the two alternatives, or possibly a compromise.

The process of going from a resource problem someone has identified to selection of an equitable plan involves basically five steps:

1. First, important components of each of the objectives have to be clearly identified as they relate to the specific site or area where the planning is being done. For example, increased farm yields might well be an important component of the economic objective. At the same time, improvements in water quality by eliminating sources of fertilizer and pesticide runoff from farms could

well be an important component of the Environmental Objective. As you can see, there are tricky trade-offs right from the beginning, and a clear understanding of public preference is essential.

2. The second step is to evaluate existing natural and economic resource capabilities and then determine what future economic and environmental conditions might be without a coordinated plan.
3. Third, the planners must begin to develop alternative plans for solving perceived problems--perceived, that is, by both the planner and his constituents, the affected public.

In keeping with the two-objective system, the alternative plans will reflect varying emphasis across the spectrum of economic development and environmental quality.

4. In step four, the beneficial and adverse effects of these alternative plans are examined against four accounts:
   - national economic development, including perhaps increases in goods and services, such as water supply, more efficient production and use of energy, flood prevention and improved public transportation;
   - environmental quality, such as improved water quality, wetlands and wildlife protection, open space and green belt provisions, wilderness areas;
   - regional development, including beneficial and adverse effects on employment and regional income, improved population distribution; economic stability, and finally
   - social well-being, including beneficial and adverse effects on income distribution, life, health, safety, education, and cultural opportunities. With this information in hand, the monetary and nonmonetary differences between, and trade-offs among each alternative plan can be clearly shown, and a rationale can be developed for choosing the best alternative plans to meet the two-objective system.

   For example, a plan may emphasize contributions to the EQ Objective and, in addition, include complementary contributions to the NED Objective, such as water supply for municipal and industrial needs.

Another plan might include significant contributions to the NED Objective and, in addition, include contributions to the EQ Objective, such as consideration of water quality, fish and wildlife, and flood plain zoning.

5. The fifth and final step is the selection of a recommended plan from among the alternatives available. Because of constant public input to this planning process, the final recommended plan will, to the best of current understanding and knowledge, reflect the preferences and economic-environmental emphasis desired by the public involved. Of course, this five-step process includes constant review and revision as opportunities and problems arise. Adequate planning is therefore a continuous, dynamic and analytic process which must be coordinated at all levels to produce a recommended plan.

The foregoing paragraphs have described the basic five steps to take in selecting an equitable plan, but regardless of the other steps, won't a plan be turned down unless it shows net national economic benefits?

Not necessarily. A recommended plan must have net economic benefits unless the deficiency in net benefits results from additional economic costs incurred to serve the environmental quality objective. In other words, a plan with less than net economic benefit can go through if it has overriding long-term environmental benefits. In addition, an exception may also be made by an agency head for consideration of overriding social or regional values.

As explained earlier, the new Principles and Standards apply to Federal projects and planning programs and to comprehensive Federal-State planning, such as that conducted by river basin commissions.

With respect to the many programs and projects authorized but as yet unfunded--decisions as to which of the backlogged projects will have to be reformulated will be made by each Federal agency head. These will be difficult decisions. The Corps of Engineers, for example, has about 375* unfunded but authorized projects with an estimated total construction cost of over $10 billion. It is conceivable that some of the projects will be exempted from the application of the Principles and Standards whereas others may be reformulated.

---

*"Water Spectrum," Vol. 6, #4, 1973.

The discount or interest rate at which benefits and costs are adjusted to a common time basis for evaluating future water resource projects and programs. Prior to March 7, 1974, the discount rate established by the Principles and Standards was 6-7/8 percent. This was based on the average cost of Federal borrowing as established by the Secretary of the Treasury. However, Congress, in Section 80 of the Water Resources Development Act of 1974, reestablished the discount rate formula based on the Council's December 24, 1968, discount rate rule (5-5/8 percent).

In addition, Congress requested the President to make a full investigation and study of the Principles and Standards, including such items as the discount rate, a Four-Objective system instead of the current two, and Federal cost sharing. With the exception of the discount rate and its application, the Principles and Standards as published remain in effect.

The key word in implementing the Principles and Standards is "flexibility." Each Federal agency has a number of plans nearly completed--which represent hundreds of thousands of man-hours of effort, and millions of dollars of planning funds.

Rigid initial application of the Principles and Standards with no transition period would drastically increase the costs of these projects, cause great delay, and substantially negate the benefits which would accrue from timely approval. To overcome this difficulty, the Council has developed a procedure for retroactive application.

In the meantime, each agency is preparing and submitting to the Council its implementing procedures for consistency with the Principles and Standards. The Council recently completed its review of Agriculture's procedures and will review other agency procedures as developed. We anticipate momentary receipt of procedures from the Departments of Interior and Army.

In turn, the Council is preparing certain Procedures, such as Procedures for applying the Principles and Standards to basin planning to assure consistency and interagency cooperation, and to assist on such technical subjects as retroactive application, evaluation of the social well-being and regional development accounts and cost allocation.

Emerging Policies

These Principles and Standards have significant policy overtones that have resulted from conscious decision making. They are the vehicle or lay the basis for emerging water policy considerations.

Several such issues are enumerated below. These will be elaborated upon more fully during the "Windup" session of the last day.

1. Planning Objectives. The present process calls for two co-equal objectives--economic development and environmental quality and the development of alternative plans which will give voice to divergent concerns among a wide variety of public desires. Congress in Section 80 of the 1974 Water Resources Development Act raises the question of adding two additional planning objectives for Regional Development and Social Well-Being.
2. Cost Sharing. Many individuals believe that cost sharing--the method of financing water projects, is the key water policy issue. What should be the level of cost sharing by project beneficiaries (direct and indirect) and that of the Federal, State and local units of government?
3. Discount Rate. This continues to be a most controversial issue with those supporting development pushing for a lower rate whereas conservation groups and others opposing development strive for a higher rate.
4. Integration of water quality, water quantity and land planning. The need for such integration is obvious, however, the process to accomplish appropriate integration has not been developed.
5. Coordination of Level C planning recognizing priorities of need and relationship to completed comprehensive plans.
6. Inventorying and quantification of reserved, appropriate and other Federal water rights. This matter particularly sensitive in the Western States because of large blocks of Federal lands and existing State water laws on appropriative rights.
7. Institutions. Are present institutions at all levels of government so organized to efficiently administer national resource

programs? How successful have been such interagency mechanisms as WRC and RBC's? Do we need a more authoritative organization such as the proposed Federal Department of Energy and Natural Resources?

The issues I have listed above are just a few of the many nagging water policy issues facing our Nation. Generally speaking, our Nation's water policy has evolved--much of it on a hit or miss basis as a need or an issue which has surfaced. Congress in requesting the one-year Presidential Section 80 study is stating that the time has come for a comprehensive overview to be made of our water policy. The interface and interactions of many policy issues must be concurrently analyzed. The controversy of the discount rate is a good example of looking at and isolating just one issue.

The Principles and Standards do have strong policy implementations. They afford a vehicle to: (1) assist in allocation of scarce resources; (2) display trade-offs in form of alternative plans for emphasizing two objectives; (3) recognize that both quantifiable and nonquantifiable benefits and costs need to be considered; (4) demand public participation; (5) require interdisciplinary inputs; and (6) afford greater detail in the evaluation and formulation process.

PLANNING PROCESS AND ITS INSTITUTIONAL SETTING

Gary D. Cobb
Assistant Director, U.S. Water Resources Council
Washington, D.C.

This paper will further amplify the planning process and the institutional setting addressed in Director Fairchild's paper on "Overview of Principles and Standards". After reading both papers, hopefully the result for everyone will be a better understanding of what's involved in the implementation of the Principles and Standards.

It has been stated that the Principles and Standards have no structure; that the planning process is fuzzy, fluid, or indeterminate, representing a wide band of potential tradeoffs, and; that there is no form, structure, or discipline in the planning process. Let us start with, in a sense, the opposite view, and see how well a case can be developed, indicating the Standards and Principles do have form, structure, and discipline even though the P&S deals with many incommensurable values.

Review of Objectives

First, the objectives should be reviewed. A key aspect of the Principles and Standards in terms of providing form, structure and discipline is in the conceptual definition of the objectives. It is not intended to cover this in great detail, as other papers will be devoted to discussions of each objective. But please note that the planning objectives are explicitly and uniquely defined, and thus provide the basic foundation for the planning process.

The NED Objective

The National Economic Development (NED) objective is defined as follows: "To enhance NED by increasing the value of the Nation's output of goods and services and improving national economic efficiency" (Page 6 P&S). Components of the NED objective which are to be considered in the planning process include water supply, flood control, power, transportation, recreation, commercial fishing, external economies, and other outputs including the use of otherwise unemployed or underemployed labor resources in the construction or installation of the plan. Accordingly, it can be seen that this objective is uniquely and explicitly defined.

The EQ Objective

Similarly, the Environmental Quality (EQ) objective is defined as follows: "To enhance the quality of the environment by the management, conservation, preservation, creation or restoration or improvement of the quality of certain natural and cultural resources and ecological systems" (Page 6 P&S). Components of this objective include a) open and green space, wild and scenic rivers, lakes, beaches, shores, mountains and wilderness areas, estuaries, and other areas of natural beauty; b) archeological, historical, biological and geological resources and selected ecological systems; c) the quality of water, land and air resources and finally, d) a component which is not quite the same as the other components, is that component dealing with the irreversibility of commitments that we make in decisions, in terms of future uses of resources. Note that this objective deals basically with the natural environment as, say, opposed to or as distinct from, the human environment, which the environmental quality objective encompasses as defined in the National Environmental Policy Act of 1969 (NEPA). Thus, the definition in Principles and Standards of environmental quality is somewhat different than that provided in the National Environmental Policy Act of 1969 with the social and cultural aspects of the human environment being addressed in the regional development and social well-being accounts. Thus, the environmental quality objective is also uniquely and explicitly defined albeit somewhat differently than in NEPA.

Incommensurable Values

When the planning process addresses incommensurable values--that is, one objective is being considered in terms of monetary evaluation, or market evaluation--and another objective is being considered in other appropriate quantitative units or qualitative terms, it is possible conceptually for the objective reflecting monetary values to formulate plans or formulate contributions toward that objective, using optimizing techniques which involve mathematical optimization. Similarly, if we had common value units, and a system of weights, it would be possible to bridge the gap or make commensurable, if you will, the two objectives, and in effect merge them into a single objective function and apply mathematical optimization techniques. We would deal in marginal benefits and costs, a concept that's basic to planners. But, inasmuch as we don't have a common set of value units or a system or set of relative priorities, nor are we likely to have such a set of priorities any time in the near future, then we address quantification of these objectives where possible, in quantitative units or qualitative terms appropriate to the objective as defined. Inasmuch as we don't have common value units nor a system of relative prices or weights, we have to deal with these incommensurable values in other ways in the planning process.

Transformation Function

Conceptually, we can characterize the transformation function in terms of net contributions to the two objectives. Net contributions to the national economic development objective would include, of course, net NED benefits to water supply, flood control, power, transportation, recreation, etc. Net contributions to the NED objective is for the most part straightforward because first of all, most people would agree with respect to their preferences or values they apply to contributions to the national economic development objective. Not all would, however; for example, some opponents to unrestrained population growth right now would say that in and of itself, increasing the value of national output may not be in the interest of society. If that increase in the total value of national output, GNP, is the result simply of increase in population, with say decreasing output per person, it would be opposed. If the increase accrues as a result of increasing productivity per person, then it would not be opposed. Thus, even national economic development now is not as commonly an agreed upon objective as we had thought heretofore.

Concept of Net EQ Benefits and Adverse Effects

In case of the environmental quality objective, the concept of net contributions or net EQ benefits is much less straightforward. First of all, many people will not agree as to what is a beneficial or adverse effect toward the environmental quality objective. Further, we find that there are tradeoffs within the objective involving incommensurable values; that is, certain environmental contributions resulting from an environmental plan would be considered to be beneficial by most, while there may be certain other environmental effects resulting from the same plan which would be considered to be adverse; and later on I'll illustrate an example of how this might be the case. So I want to emphasize that the concept of net contributions to the environmental quality objective while correct conceptually, represents a major problem for planners to make operational in the planning process. Let's assume, however, that it will be possible through appropriate public involvement in the planning process to identify a collective sense of priorities and preferences with respect to the environmental quality objective and thus we are able to derive in a subjective way a sense of the level of net contribution to the EQ objective.

In the portion of the transformation function (Figure 1) ascending upward and to the right, alternative plans reflecting complementary contributions toward the objectives are represented by the cross-hatched parts of the curve on which Xa and Xe are points. These alternative plans are really irrelevant to the decisionmaking process, because they represent complementary

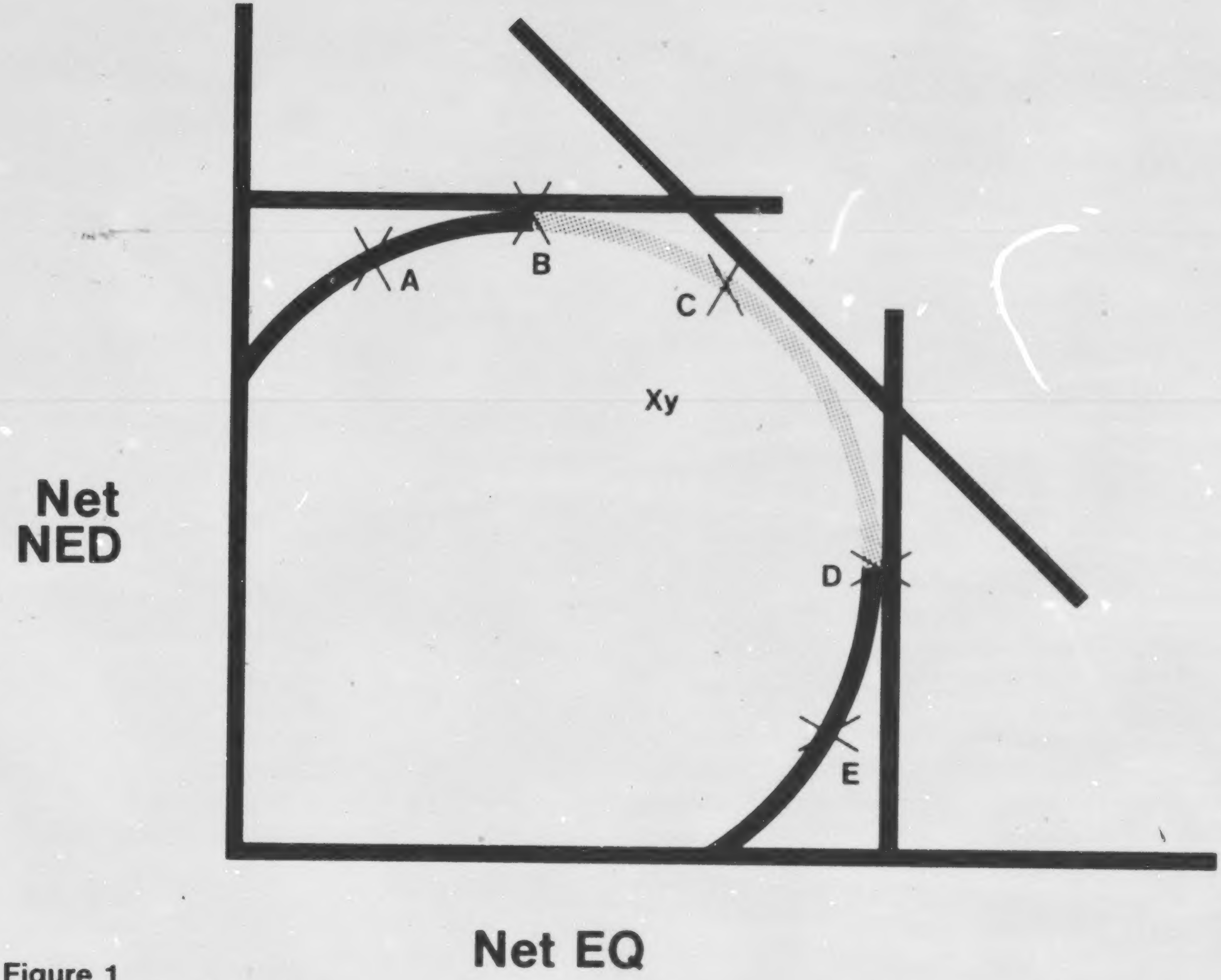


Figure 1

contributions to the two objectives, and therefore they do not enter into the decision-making process about tradeoffs. This could be a case where an environmentally oriented component is being incorporated into an NED emphasized plan yielding net positive incidental NED benefits, and in the case of an EQ emphasized plan where a complementary NED output such as urban water supply is included and there is no major environmental objections. One alternative plan required under the Principles and Standards is that which optimizes the net contributions to national economic development. That plan is represented by the Xb, on top of the curve. Note that the transformation curve or transformation function breaks at this point and starts moving downward and to the right. This means we're getting tradeoffs, then, between the two objectives. The emphasized EQ plan could be characterized graphically in this case, starting from the low point on the curve, by Xd where the curve breaks and starts moving upward and to the left. At that point all complementary NED contributions have been accounted for. We're now at a point where we have a major public expression of conflict arising between the objectives, and are now in the process of considering tradeoffs. The Principles and Standards provide the other alternative plans be formulated so as not to overlook a best overall plan. Such alternative plans, such as Xw, may take into account and reflect significant physical, technological, legal or public policy constraints, as well as reflecting significant tradeoffs between the national economic development and the environmental quality objective.

Any alternative plan, Xy, that would fall under this transformation function is also irrelevant. Such an alternative plan is not the most effective or efficient technologically or physically, in achieving the objectives and as the planning process is iterated the boundary of that transformation function is moved out as far as possible, reflecting the fact that there's a better, more effective alternative for that level of tradeoff.

The Planning Process

The planning process is an iterative process; it starts with specification of the components of the objectives relevant to the planning setting. In specifying these components, then, we address the objectives as defined. At this point--I will discuss exceptions later--we are concerned about planning for component needs which fit under the definition of the two planning objectives and thus those components mentioned earlier are reviewed in identifying the output, economic and environmental, that is to be sought in managing the natural resources. How do we know what the component needs are? How do we know what the component needs are for environmental quality? Because it is a subjective consideration, it's absolutely essential that we have public involvement in consideration of this objective particularly, although it is required also for the NED objective. Early in the planning process, broad and fairly intensive public involvement is essential. Otherwise, we would not know whether there's any existing preference or value attached to any potential environmental condition, either as an induced adverse effect of the plan or as a potential contribution.

The next step in the planning process then deals with evaluating resource capabilities and expected conditions without any plan. This is the traditional projected "without" situation or condition in planning as opposed to the before and after situation or condition.

The without condition conceptually, could be a separate alternative plan, but in the Standards, it is not because it would involve one more step when you compare alternative plans. If the without condition is a separate alternative, then in comparing two other alternative plans each has to be related to a common base to identify the tradeoff and thus results in another step into the comparison of alternative plans. In this step of the planning process, as well as in the specification of components, projections and how they're to be used in the planning process is crucial. Two papers have been prepared dealing with economic and environmental projections.

The third step provides for formulation of alternative plans and again here, we can relate this back to the transformation function; we're trying to identify the transformation function and that's the reason we formulate these alternative plans with varied mixes of outputs to the two objectives, really without at this point any preconceived feel for preferences or priorities on the tradeoff. In other words, at this point in the planning process, the mix is deliberately varied, even though there may be a feeling intuitively that such a plan would have very little support because of the degree of emphasis of one or the other of the objectives. After public review, a screening process can be initiated in order to narrow down the transformation function to those plans, I think we say in the Standards, which are significantly different so that they show significant tradeoffs. The alternatives should not be so close that they're shades of one another; on the other hand, alternatives should be enough different so that they can lead to a meaningful decision. The number of alternative plans to be formulated is not specified other than in a sense of minimum in the Standards, and the minimum would be two; one optimizing NED objective and one emphasizing EQ objective. The number beyond that is judgment on the part of the managers of the planning process. It's judgment coupled with, I would say, their reaction to the public involvement and how relevant or how concerned or what preferences or values are being identified in the planning process to this point.

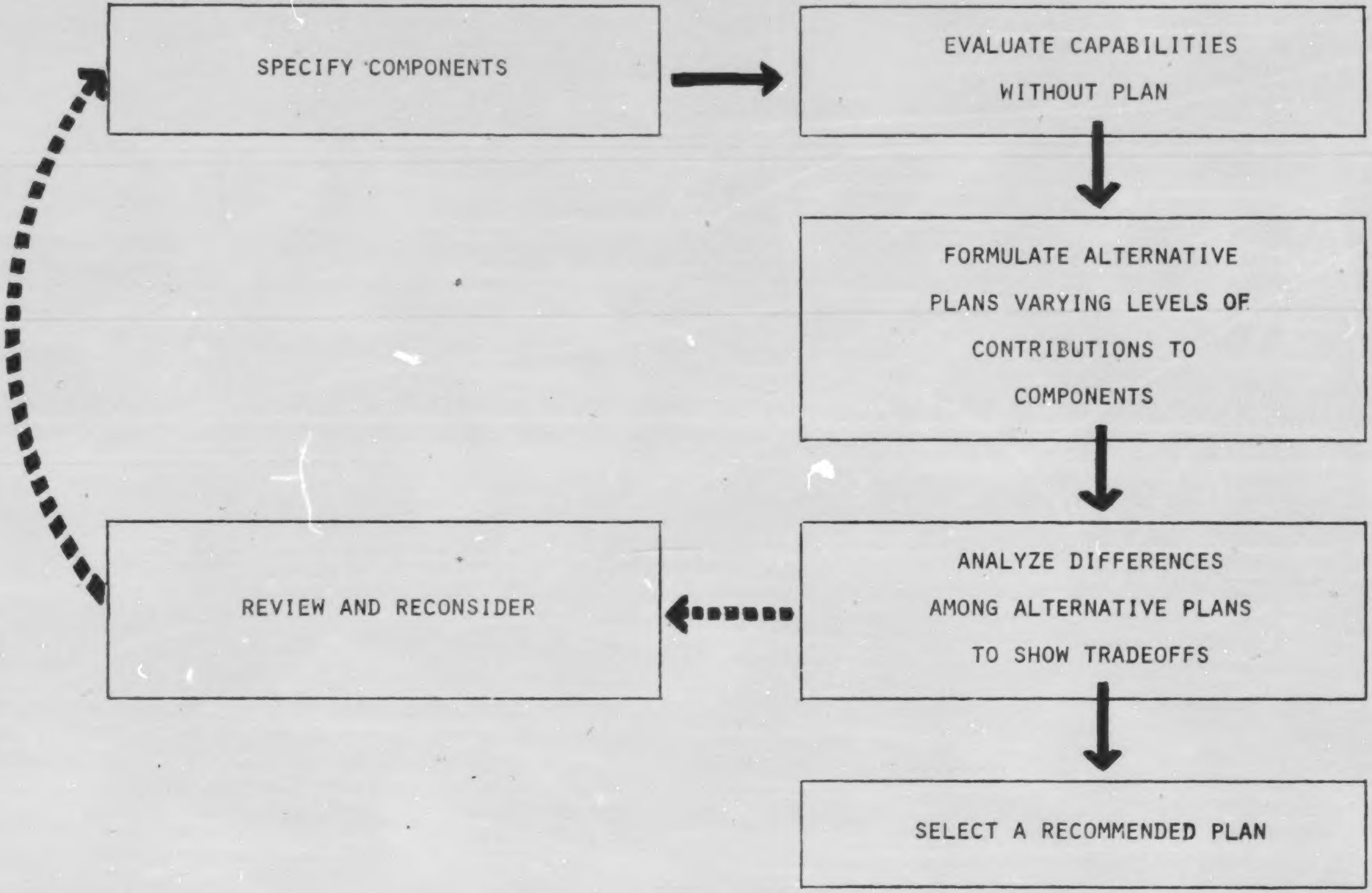
Let me just note that the other steps are: compare the alternative plans, review, reconsider, iterate, and then the final step would be selection of a recommended plan, but we'll come back to this (Figure 2). I'd like to now turn to a discussion of how one might go about finding an optimized NED plan.

Optimized NED Plan

Inasmuch as the planning process is an iterative process, the identification--the final identification, of these alternative plans--that is, the plan that's identified as the optimized NED plan, or the plan that's identified as the emphasized EQ plan, may come at the last iteration. The process is imitated with a review of the NED components, and their relative efficiencies and what may be done in resource **management**, to achieve component needs of the NED objective. As the iterative process goes on, each alternative plan is perfected including these that optimize and emphasize NED and EQ.

Figure 2

PLAN FORMULATION


SPECIFY COMPONENTS
EVALUATE CAPABILITIES WITHOUT PLAN
FORMULATE ALTERNATIVE PLANS VARYING LEVELS OF CONTRIBUTIONS TO COMPONENTS
ANALYZE DIFFERENCES AMONG ALTERNATIVE PLANS TO SHOW TRADEOFFS
SELECT A RECOMMENDED PLAN
REVIEW AND RECONSIDER

Marginal analysis, is applied in scaling of the final increment of the NED plan. In this example, a plan with 100 benefits over 50 costs with net benefits of 50 has been formulated. The next increment has benefits of 10 costs of 8. As it's a favorable increment, it would be added. In the final increment, marginal benefits are equalled by marginal costs. It's not quite as simple as this, however, because internal to the plan there should be equal marginal returns, the same marginal returns for each component, or each output, so that we've got not only optimization of the entire plan, but optimization among components (Figure 3).

Emphasized EQ Plan

In the case of the EQ objective, the marginal concept is based on presumed priorities and preferences of affected groups, recognizing that not all may agree on whether certain effects are beneficial and adverse. This objective is a real challenge in terms of any kind of optimizing concept because you're dealing with subjective values, subjective values which various people will not agree on. However, in the planning process, dealing with a broader cross section of the public involved or affected should indicate some sense of where there's more consensus than elsewhere and marginal analysis, the concept of marginal analysis or of the marginal increment would apply equally in concept to this objective (Figure 4).

Mixed NED-EQ Plan

In the case of the mixed NED-EQ plan, the Standards provide that the contributions to both objectives should exceed incrementally the adverse effects on both objectives. Now, since we're dealing with incommensurate values, this means that this is also a subjective determination. To illustrate the point, if at some scale of a two-objective plan, we have 100 over 90 with net of 10 in the NED account and for that same scale of development we have 10+'s over 5-'s in the EQ account we might say we would add an increment which would have an effect on NED to add 10 to benefits and 20 to costs to achieve an effect on EQ to add 5+'s to benefits and 2-'s to costs. Similarly, for the next increment based on the public input and public preferences, a higher level of tradeoff marginally may be accepted that the public would consider as being a preferred set of tradeoffs, so that here again you might be considering an addition of 10 of benefits, 30 of cost, to achieve 5 more plus's to EQ benefits, 1 more minus to EQ costs (Figure 5).

Figure 3

OPTIMIZED NED PLAN

	SCALE PRIOR TO FINAL INCREMENTS	SCALE WITH NEXT INCREMENT	SCALE WITH FINAL INCREMENT
NED BENEFICIAL EFFECTS	$100	(+10) $110	(+10.0) $120.0
NED ADVERSE EFFECTS	50	(+ 8) 58	(9.9) 67.9
NET NED EFFECTS	$ 50	$ 52	$ 52.1

Figure 4

EMPHASIZED EQ PLAN

	SCALE PRIOR TO FINAL INCREMENTS	SCALE WITH NEXT INCREMENT	SCALE WITH FINAL INCREMENT
EQ BENEFICIAL EFFECTS*	+++++ +++++	(+++++) +++++ +++++ +++++	(+) +++++ +++++ +++++ +
EQ ADVERSE EFFECTS*	-----	(----) ----- ----	(0,9-) ----- ---- 0,9-

*BASED ON PRESUMED PRIORITIES AND PREFERENCES OF AFFECTED GROUPS, NOT ALL MAY AGREE ON WHETHER CERTAIN EFFECTS ARE BENEFICIAL OR ADVERSE.

Figure 5

MIXED NED-EQ PLAN

	SCALE PRIOR TO FINAL INCREMENTS	SCALE WITH NEXT INCREMENT	SCALE WITH FINAL INCREMENT
NED			
BENEFICIAL EFFECTS	100	(+10) 110	(+10) 120
ADVERSE EFFECTS	90	(+20) 110	(+30) 140
NET	10	0	- 20
EQ			
BENEFICIAL EFFECTS	+++++ +++++	(+++++) +++++ +++++ +++++	(+++++) +++++ +++++ +++++ +++++
ADVERSE EFFECTS	-----	(--) ----- --	(-) ----- -- -

The marginal increment of tradeoff would be a matter of public preferences, and technically, then, this would relate back to the slope of the transformation function or curve. At any point on that slope, there is a mathematical tradeoff that is involved, so that this marginal increment then can be related back to the slope on any transformation function, in a mathematical sense.

Comparison of Alternative Plans

The selection of a recommended plan, once the alternatives are formulated, is based on comparison of alternative plans. Illustrated are two examples of alternative plans; one is an alternative power plan; the other in this example is assumed to be a selected plan to be recommended to a higher level in the decision-making process, and is a wild and scenic river plan. Note that the power plan has net benefits of $20 in the NED account. The wild and scenic river plan has net negative benefits of $20 in the NED account. The wild and scenic river does generate NED outputs in the form of user recreation days. It may also have a net NED benefit for water supply. We see that there has been a tradeoff of net NED benefits foregone between the two alternative plans in NED account of -40. Further, note that there is an evaluation of each of the alternatives on each of the accounts.

In the Principles and Standards, the four (4) accounts have been explicit and uniquely defined, and thus by comparing alternative plans, information is provided about the tradeoffs in the same account and among the accounts for the two (2) alternative plans being compared. Inasmuch as it was envisioned that we would be dealing with a series of alternative plans, each of which was to be compared with the selected plan at any level of the decision-making process, it was felt important to keep the tradeoffs as a separate column providing for a clear expression of the tradeoff. Beneficial and adverse effects are shown in the EQ account for the two alternative plans. Note that beneficial and adverse effects are lumped together; and are not shown separately, as in the NED account. The reason for this is the potential lack of common agreement about whether effects are beneficial or adverse. In effect, each decision maker is going to have to judge these effects and make an assessment, an appraisal, in his mind of what he perceives the consensus viewpoint of the affected publics or groups to be for any effect and whether it is beneficial or adverse (Figure 6).

Figure 6

	ALTERNATIVE POWER PLAN	SELECTED WILD, SCENIC, RIVER	DIFFERENCES, TRADEOFF
NED			
BENEFICIAL EFFECTS	100	10	-90
ADVERSE EFFECTS	80	30	-50
NET	20	-20	-40
EQ			
BENEFICIAL AND ADVERSE EFFECTS			
WILD, SCENIC RIVER	INUNDATE 90 MILES	PRESERVE, OPEN LIMITED ACCESS	DO NOT INUNDATE PRESERVE WITH ACCESS
HISTORICAL SITE	ENHANCE ACCESSIBILITY, EDUCATIONAL VALUES	DO NOT ENHANCE ACCESSIBILITY, EDUCATIONAL VALUES	DO NOT ENHANCE ACCESSIBILITY, EDUCATIONAL

RD & SWB - SIMILAR COMPARISON OF BENEFICIAL AND ADVERSE EFFECTS.

I want to point out that within the EQ accounts there are potential tradeoffs so that when a decision maker then is making the judgment about these alternative plans, he is dealing not only with tradeoffs between accounts, but within accounts. Similarly, then, we would have for the regional development account and the social well-being account a display of beneficial and adverse effects. Our evaluation and comparison of alternative plans presents a complete display of the tradeoffs involved. Further, both sides of tradeoffs are shown and may be considered from the viewpoint of either objective. This then would be the basis for the recommendation of a selected plan that would go forward in a decision making process for approval.

Four Plan Formulation Tests

In the planning process, there are four plan formulation tests involved which provide additional structure and discipline to the planning process. The first deals with the acceptability of the alternative plan to the public and compatibility with institutional constraints. This is another area where the planners involved in the planning process are going to have to apply substantial judgment. Recognizing that there are certain institutional constraints that may have to be taken into account in the planning process it may be desirable to take a second look at these constraints. That second look would be directed to the feasibility of lifting those constraints in order to open up the choices and tradeoffs on the objectives.

The second test deals with the effectiveness of the alternative plan in meeting component needs of the objectives. This test requires that a plan is effective in accomplishing contributions to the objectives and that the plan makes not just marginal contributions but rather significant contributions to the objectives.

The third test deals with the efficiency of the plan in meeting component needs of the objectives and a demonstration that the plan represents the least-cost means of achieving such component needs. The test requires that, with respect to all alternative means--structural, nonstructural, federal, non-federal--the plan is effective and efficient in achieving contributions to the objectives.

The fourth test deals with the completeness of the plan in accounting for all investments and other required inputs or actions. This test requires that beneficial and adverse effects be accounted for in the same dimension or scope. If third-round beneficial effects are measured, third-round adverse effects should be measured, providing for a completeness and consistency in the evaluation process. As alternative plans are developed and subjected to these tests, the planning process is iterated (Figure 7).

Review and Reconsideration

Such iteration should be based on review and reconsideration of the following kinds of considerations:

Level of detail was inadequate as a basis for selection of a recommended plan.

Alternatives considered result in significant shortfalls in meeting the component needs.

Public policy changes occurring during the planning process suggest change in emphasis for the objectives; or

Additional information may be obtained during the planning process.

Selection of a Recommended Plan

The Principles and Standards provide that there will be a recommended plan selected during the planning process. It is somewhat unclear or uncertain right now in terms of each agency's procedures of whether that plan selection process is going to be open process or whether it's going to be more internalized into the agency's decision making process up until the agency head announces his position. Each level of the decision making process will perceive priorities and preferences of the affected groups of all levels from a different perspective and should be expressing to the best of his ability what he perceives to be the priorities and preferences of the affected public at all levels from his perspective. In the illustration, the priorities or preferences of the affected public at all levels may be represented by any of the three heavy black lines. The process becomes more meaningful if such perceptions are revealed even internally at each level in the decision making process.

The Standards provide that a recommended plan must have net national economic development benefits, unless the deficiency in net benefits for the NED objective is the result of benefits foregone or additional costs incurred--NED benefits foregone, NED costs incurred--to serve the environmental objective.

Figure 7

FOUR PLAN FORMULATION TESTS

**ACCEPTABILITY TO PUBLIC AND COMPATIBILITY WITH INSTITUTIONAL CONSTRAINTS

**EFFECTIVENESS IN MEETING COMPONENT NEEDS

**EFFICIENCY IN MEETING COMPONENT NEEDS AND LEAST COST MEANS

**COMPLETENESS IN ACCOUNTING FOR ALL INVESTMENTS AND REQUIRED ACTIONS

It's simply a word definition of the transformation function. In such cases, a plan with less than a unity benefit-cost balance--somewhere along the transformation function, the net NED benefits are going to become negative--less than a unity benefit cost balance may be recommended as long as the net deficit does not exceed the benefits foregone and the additonal cost incurred for the environmental objective. A Departmental Secretary or head of an independent agency may make an exception to the net benefits rule as applied to two objectives if he determines that circumstances unique to the plan formulation process warrants such exception. Such circumstances can include consideration be other concerns and values such as represented by the regional development and social well-being components. I should also add, however, that when the members of the Council were considering this, they weren't thinking that a lot of exceptions would be made.

Public Involvement

A major comment that we received during the public response to the proposed Principles and Standards was the need to have public involvement in the planning process. The Standards provide that public opinions be solicited early in the planning process; that periodic expression of the public's views orally be encouraged along with recording of opinions; that public meetings be held early in the course of planning; that lines of communication be opened to receive views of the public; and that all plans, reports, data analysis, interpretations and other information be made available for public inspection. The Standards are quite broad with respect to public involvement reflecting the experience that not one technique works in every case and that flexible approach, but one incorporating the above concepts and policies, may be taken.

Institutional Setting

The Director has indicated the Principles and Standards apply to all levels of planning and that the key in application is related to the manner in which the objectives are specified in the first step in the planning process for each level of planning. The Principles and Standards will guide Federal participation in comprehensive planning and apply to certain direct Federal programs and the Federally assisted program of the Soil Conservation Service.

In river basin commission areas or in areas with interagency committees or other regional institutions we have a mechanism for interagency, interdisciplinary, intergovernmental input into the planning process. Where we are dealing with subjective values in the planning process, interagency, interdisciplinary, intergovernmental input is essential to the planning process. In implementation planning (Level C) special efforts may be required. We may not be as well geared up. The Principles and Standards have not addressed this matter. In the future we are likely to have lead agency planning with interagency input and the interdisciplinary input coming through the technical disciplines that are available in all of the agencies that are involved at the Federal and State level in the planning process. In dealing with these incommensurable objectives, again it is essential that an interdisciplinary plan formulation approach be used.

Conclusion

In conclusion, the Principles and Standards provide for an open planning process more responsive to the priorities and preferences of the affected public at all levels in planning for the management and utilization of the Nation's water and related land resources.

NATIONAL ECONOMIC DEVELOPMENT (NED) OBJECTIVE

Robert A. Young
Department of Economics, Colorado State University
Fort Collins, Colorado

This report presents the conceptual basis underlying the National Economic Development Account in the Principles and Standards for Planning Water and Related Land Resources (Federal Register, Vol. 38, No. 174, Part III, September 10, 1973). It is intended to document and supplement the material presented orally in the Training Program at CSU, August 12-23, 1974. A related report has been prepared which discusses techniques of measurement appropriate to implementing the concepts reviewed here.

National Economic Development and the Role of Water Resources Investment

Economic growth has long been an explicit objective of U.S. economic policy. Growth as a goal has come under some question in recent years, as groups in the economy have challenged the premise that increased output of marketable goods and services necessarily increase the nation's welfare. Indeed, the expansion of traditional benefit-cost analysis to incorporate multiple objectives, as evidenced by the Principles and Standards under discussion here, is evidence of significant discontent over the dominance of economic growth as the prime objective of public water development policy. Nevertheless, the development goal remains an important one, and will continue to play an important role in national water planning.

Water resource investments, via the various traditional means which include irrigation, flood control, navigation, recreation, hydropower, etc., contribute to increased national economic product in at least two ways. First, such investments allow a given list of goods and services to be produced with fewer resources, thereby freeing some resources to produce other valued outputs. Alternatively, water resource investments may increase the goods and services produced from a given set of resources. In either case, carefully planned investments in water resources can increase productivity of land, (as well as labor and capital) and thereby contribute to the objective of growth in the national economy. For example, irrigation water can vastly improve the output of land resources under arid conditions, while navigation works can provide the basis for less expensive transportation services, increasing the economic productivity of water flows. Further, such activities are properly performed by the public sector, since private capital may not be available which will invest on a sufficiently large scale or for an appropriately long planning horizon, or because the public interest will not likely be served by a private monopoly in control of these outputs.

Measures of National Economic Growth

The most familiar measure of economic output, albeit a somewhat crude one, is Gross National Product (GNP), which expresses the sum total of all marketed goods and services produced by the economy, each measured in terms of its monetary value. When converted to a per capita basis, comparisons of the Gross National Product in various time periods provides an index of the degree to which the economy provides individual members with increasing amounts of desired goods and services.

When goods and services are produced by the public sector, rather than in the private economy, a number of special problems of concept and measurement arise. Goods and services produced by government agencies are typically not exchanged or priced as goods and services in the market economy. Hence, the necessary economic functions of valuation of resources and rationing consumption to match limited productive capabilities must be performed by alternative mechanism. The Gross National Product does not measure unpriced goods and services, nor are disamenities associated with economic production and distribution deducted from it. Hence, in public sector planning more refined measures of national economic welfare are required.

The analytical procedures commonly termed "benefit-cost analysis" have been developed and refined to meet this need in public sector investment decisions. Traditional benefit-cost analysis as practiced in the water resources field has emphasized economic efficiency and economic growth as the principle goal. Benefit-cost analysis differs from investment planning in the private sector principally in that public planners attempt to assign values to impacts or outputs (both favorable and adverse) which are not priced in the market economy, in addition to those that do fall into the market system.

Wants, Resource Scarcity and the Economic Problem

A. Wants and Resource Scarcity and the Functions of an Economy

Few of us are able to satisfy our wants with the means we have available. We might desire a better diet or improved housing. On less basic grounds, we might prefer a more varied wardrobe, a newer automobile or a longer vacation. For practical purposes, the means for satisfying wants are limited. Resources, the ingredients of want-satisfying goods and services are finite in supply. Nations differ in their ability to supply the wants of their citizens according to their endowments of both natural and capital resource and level of available technology.

Economic activity is the use of resources to satisfy wants. It consists of production, consumption and exchange, together with all their ramifications. We expect economic activity to be directed toward increasing the well-being of the nation's population. The well-being of the population is, in most western democratic societies, based on the expressed preferences of that population. This notion is termed consumer sovereignty.

In order to satisfy the wants of its members, an economy must perform several functions. These functions include a) determining the relative value of goods and services, b) organizing production so as to continually reorient resources toward producing goods which are deemed to contribute most to want satisfaction, and c) divide the output among the people who compromise the system.

B. Economics in Non-Market Contexts

A predominantly private enterprise economy, such as our own, performs the above functions through private production of goods and services and voluntary exchange in markets. Prices and profits provide the guiding mechanism for allocating resources and commodities as its members seek to enhance their individual well-being. Economics as a discipline studies the operation and functioning of economic systems, seeking to describe, explain and predict the behavior of the elements of that system.

Our economy is mixed, in the sense that a public sector exists side by side with the private market economy. An important part of the public economy consists of ecosystem management; consider as examples, the forests, grasslands and game herds managed for the public by state and federal agencies. Economics makes an important contribution to problems of public resource allocation.

One of the most important functions of economics is to evaluate public policy. Economics, contrary to common understanding, begins with the postulate that man is the measure of all things. Things which contribute to human health and happiness are more directly "economic", and therefore more important than property, which is simply an intermediate means to health and happiness. Neither do economists regard "economic" as a synonym for "pecuniary". Rather, money is but one of many means to ends as well as a useful measure of value.

Rational planning involves prediction of the consequences of alternative policies and selection of a best plan according to some ethical or normative criterion. Therefore, evaluation of public policy involves value judgments, and there must be some means of thinking about them systematically, and if possible, quantifying them. Paraphrasing a passage by Allen Kneese, we may observe that the importance of economics to the process derives from the fact that the price and allocation theory of economics and its prescriptive applications to problems of human welfare is a theory of social values. It is a theory of social values sufficiently detailed, precise and logical to assist in the derivation of decision criteria and to provide a structure for systematic, quantitative measurement. The theory is based on the premise that individual tastes and preferences are to govern the use of resources in a free society, a value judgment widely accepted in our culture.

Economic analysis plays an important role in social decisionmaking, arbitrating among the rival claims of different interst groups and disciplines. Absolutism is explicitly rejected. This is why the economist tends to speak in terms of demands and preferences, rather than requirements and needs. The basis upon which welfare economics establishes the commensurability of different goods and services is the willingness of consumers to pay for the resources necessary to produce them in view of the willingness of the same or other consumers to pay for the use of those resources in alternative employments. In this process, there are no external standards for a "good result". Rather, the desirable result is deemed to be the one that goes furthest in satisfying human wants, given limitations on resources and the prevailing distribution of income.

An idealized competitive economy will yield an allocation of resources such that no alternative pattern of resource use will make any individual better off without making someone else worse off. Such an allocation of resources is said to be "economically efficient", and given the distribution of income and the limitations on resources, is the pattern of resource allocation which will most completely satisfy human wants. Much of the process of evaluating public choices, in non-market contexts, involves simulating the results which would be obtained in the presence of an ideal competitive market economy.

Some Preliminary Concepts

A number of procedures and assumptions will be accepted as a basis for the process of determining beneficial and adverse effects.

A. General Setting for Analysis

As a general rule, full employment of resources is to be assumed. National and regional projections of population, employment and output, on which estimates of demand for outputs and services will be prepared (Mr. DeGraff's presentations elsewhere in this document will provide detailed descriptions of the concepts and procedures underlying these projections). However, the existence of localities of chronic underemployment or unemployment, is to be recognized, and accounted for in the analysis as will be discussed below.

B. With and Without Analysis

Economic and social conditions are not static, and changes in economic variables can be expected even without implementation of a plan. In order to isolate the impacts of a plan, it is necessary to compare estimated conditions *with* a plan as compared to conditions expected *without* the plan. In other words, only the incremental beneficial and adverse effects of a proposed plan should be accounted for. This precept is often referred to as the "with-and-without principle".

C. Discount Rate

Investments in water resource plans and projects involves the sacrifice of resources (and the benefits they would confer in present consumption) for future benefits. Society prefers present benefits to future benefits, a concept called "time preference". The weight attached to future benefits as compared to present benefits is given by the ratio $^{1}/(1+r)^{t}$, where r is the discount rate (usually a positive decimal fraction) and t represents the number of years into the future that future benefits under consideration will occur. The benefits of a water resource system tends to be registered over long periods, often in excess of a half-century. Since the present value of benefits is highly sensitive to the level of the discount rate, the choice of r is of immense practical significance.

At this writing, the discount rate has been specified by Congressional mandate at .05875.

D. Period of Analysis

Two considerations are relevant here. First, the discounted value of beneficial and adverse effects accruing at distant points in the future becomes negligible. Hence, for periods longer than say, fifty to seventy years, analysis of beneficial and adverse effects would have little appreciable effect on the project design. Second, technological trends may affect the economic life of a project.

The appropriate period of analysis is the shorter of the periods judged appropriate from the two considerations noted above (subject to the need for incorporating very long term environmental and/or social well-being impacts).

E. Price Relationships to Use in Evaluation

The basis for prices used in the NED account should reflect real exchange values expected over the priod of the analysis. For most cases, the relative prices existing during the planning period may be assumed to prevail over the life of the plan. Of course, in some instances, detailed studies may reveal a need to treat certain resources or plan outputs in special ways. Changes in prices due to general inflationary forces are not changes in real resource values, and should be ignored.

F. Risk and Uncertainty

The problem of imperfect knowledge arises when the analyst or decisionmaker does not know exactly what the outcome of their decisions will be. If enough information is available to assign probabilities to outcomes, the degree of knowledge about the situation may be characterized by the term "risk". For example, frequency analysis in hydrology, where actual or simulated records are analyzed to determine flow probabilities, represents a case of predictable risk.

Uncertainty is characterized by the absence of any knowledge regarding the probability of outcomes. Our knowledge of future occurrences of social and political change, wars, technological advance and, in turn, the impact of these factors on effects of programs and projects is not ordinarily representable by probability measures, and hence is described by uncertainty.

The discussion in the Principles and Standards is largely based on the assumption that all beneficial and adverse effects are more or less definitely known in advance. In cases where this is not a reasonable assumption, there is little guidance, beyond an admonition to utilize sensitivity analysis. It might be noted that incorporation of decision theory into planning activities is complex, difficult and time-consuming. There is an increasingly large amount of literature which may provide assistance in specific cases.

Sensitivity analysis--Where the accuracy of assumptions regarding economics, demographic, social and environmental trends is questionable, the plan may be re-analyzed using several alternative values of the uncertain parameters. Such alternative analyses will throw light on the sensitivity of plan feasibility and design to alternative outcomes.

Valuation of Beneficial Effects

A. Types of Beneficial Effects in the Principles and Standards

The Principles and Standards consider the following types of beneficial effects:

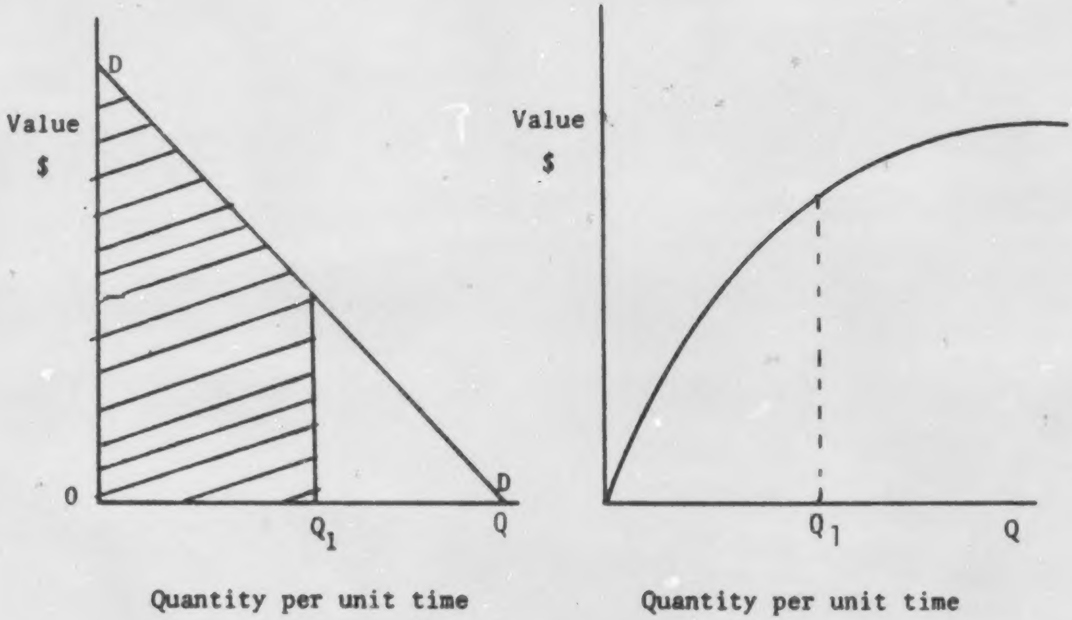
1. Value of increased outputs of goods and services
2. Value of external economies

B. Valuation of Increased Outputs of Goods and Services: The Willingness-To-Pay Concept

As noted above, the economic theory of resource allocation underlying the NED account is premised on the objective of maximizing economic welfare (Economic welfare is viewed as a more general criterion than, say, GNP, in that it incorporates estimates of the values and costs of resources, goods or services which are not appropriately accounted for in the market economy). The operational definition of the economic welfare criterion is that beneficial effects of development proposals are valued in terms of individual user's willingness-to-pay for the use of the resource rather than go without the services afforded by the resources. Further, willingness-to-pay must be backed by ability to pay, so as to insure that the measure is a sound reflection of the strength of relative preferences.

Willingness-to-pay measures what people are willing to sacrifice or give up to obtain the good or service, and thereby measures its relative value. For most goods and services market prices provide reasonably accurate measures of relative value, but for most values associated with water resource development, the price system does not yield such convenient guides. However, the concept of economic value or benefit is equally applicable to outputs of public projects. It is this willingness-to-pay, rather than what consumers are required to pay (which may be negligible or zero) which is the appropriate measure of benefits received.

The willingness-to-pay for any good or service may be approximated by the area under the aggregate demand curve for that commodity, as illustrated by a simple example shown in Figure 1(a). For any specific publicly supplied commodity, demand is in some sense limited, and the value of an additional unit decreases as quantity consumed increases. For direct consumption commodities, the individual's demand curve is conceptually derived from the



(a) Marginal Value as Related to Output of a Publicly Supplied Good

(b) Total Value as Related to Output of a Publicly Supplied Good

Figure 1

Marginal and Total Values of Public Outputs consumers utility function. Its negative slope follows from the postulate of diminishing marginal utility with increased consumption. Where the good in question is an intermediate product (producer's good), the derived demand curve may be interpreted as the value of the marginal product of the good in further production. The negative slope of the demand for a producer's good stems from the principle of diminishing returns, which asserts that added units of inputs to a production process yield successively smaller increments of output.

A more complete understanding of the role of the demand curve may be achieved by considering Figure 1(b). The total benefit or willingness-to-pay for public provision of a commodity is measured by the total willingness-to-pay for a given level of output. Define a demand curve:

$$D = f(Q) \qquad (1)$$

as in Figure 1(a). The total value of a given quantity of a public good is the area under the demand curve, i.e., the cross hatched area. In symbols the total value of some quantity (say Q_1) of publicly supplied commodity is

$$V = g(Q) = {}_{0}^{Q_1} \; f(Q)\; dQ \qquad (2)$$

The marginal value, (the demand curve f) is the first derivative (or slope) of g, while g is the primitive of f. It is appropriate to refer to g as the total value function and f as a marginal value function, such that

$$V' = f(Q) \qquad (3)$$

The marginal value of output Q per unit time is illustrated in Figure 1(a) and the total value in Figure 1(b).

Consumer's Surplus--Under normal market conditions, market value is determined by the price-quantity relation shown in Figure 2. The market value of Q_1 units of output is the area of the rectangle of OP_1AQ_1, and each unit is valued identically at P_1. Willingness-to-pay, or aggregate value, consists of the area under the demand curve evaluated at a particular level of output, i.e., the rectangle OP_1AQ_1 plus the triangle P_1BA. The triangle is termed the "consumer's surplus" and is defined as the excess of willingness-to-pay over the price which is actually paid for a particular level of output.

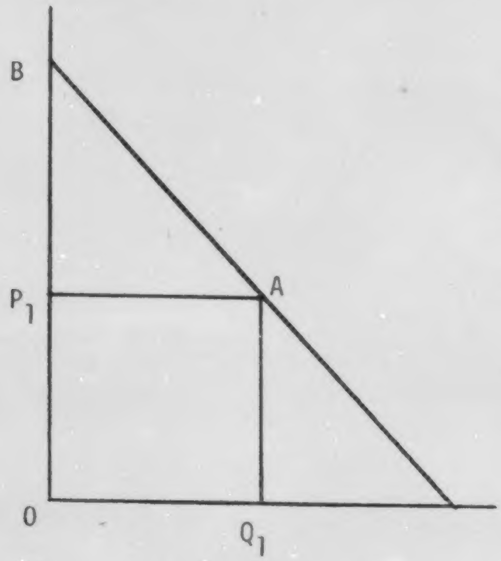


Figure 2

C. External Effects

1. Definitions and Concepts. External effects are defined as unpriced side-effects of economic activity which affect the production or utility levels of other producers or consumers. Both the interdependence and non-price conditions must hold for an externality to exist. If interdependence exists, but the effect is priced, the externality is said to be "internalized". External effects can be benefits (external economies) or costs (diseconomies).

Two types of externalities are identified, "technological" and "pecuniary". A technological externality occurs when the production function of the affected producer or the utility function of the affected consumer is altered. Pecuniary externalities relate to changes in output or utility of a third party due to changes in the level of demand.

2. Technological Externalities. This concept can be illustrated by a simple example of two firms, 1 and 2, each producing a specific commodity. The respective quantities of each producer may be labeled q_1 and q_2. By their discharges of effluent into a body of water drawn from by both, they increase each other's cost of production.

Their impacts on each other are not compensated. Denote the respective cost function:

$$C_1 = C_1(q_1, q_2)$$

$$C_2 = C_2(q_1, q_2)$$

The interdependency condition noted above is represented by the fact that the costs of each producer are affected not only by the quantity of output of his product, but by the output of the other producer.

If an increase in output of one commodity reduces costs of the other producer, a technological external economy is said to exist.

In symbols, if

$$\frac{dC_1}{dq2} \quad 0$$

an external diseconomy is said to exist.

3. Pecuniary Externalities: Nature and Applicability--Pecuniary effects represent impacts conveyed indirectly through the price system by alterations in demand and relative prices. These effects will be registered on supply or processing industries (corresponding to the terms "induced" and "stemming" effects). An increased output of an agricultural commodity will be reflected in higher demand, and hence higher profits for suppliers of farm equipment, seed and fertilizer dealers and processors. Pecuniary effects are found in changed prices and profits, but do not alter the technical possibilities of production.

It is usually held that pecuniary externalities are not relevant to evaluating real national welfare as interpreted in the NED objective. That is, they represent transfers from one sector to another via changes in relative prices, but do not reflect changes in real national output. To add pecuniary externalities and direct effects would be to double count, since the proper evaluation of increased direct output will already reflect the gains to suppliers and processors.

This is not to say that pecuniary effects are not of importance to those localities who feel their impact. Pecuniary externalities are to be dealt with in the Principles and Standards under the regional accounts. In an idealized competitive economy, the net pecuniary gains in the region of project impact will be offset by pecuniary losses elsewhere. Therefore, gains or losses among all regions in the nation should sum to zero. However, under some special circumstances, such as unemployment, resource immobility or economies or diseconomies of scale in related industries may be determined to exist. In such cases, adjustment is required in the NED account. The unemployment issue is dealt with explicitly in the Principles and Standards, and we take it up below.

Valuation of Adverse Effects on National Economic Development

The adverse effects can be categorized to include the value of:

a) resources used or displaced to produce project outputs; and
b) decreases in output resulting from technological external diseconomies

In this section, we also touch on cost adjustments required by the presence of unemployed or underemployed resources.

A. Resources Required or Displaced in Order to Produce Project Outputs

Given the scarcity of economic resources, it is clear that undertaking a public investment will divert resources from possible alternative uses. These alternative uses may be elsewhere in the public sector, or in the private sector. Thus, there is an opportunity cost to carrying out the public investment. In order to maintain consistency with our measures of beneficial effects, we require a measure of willingness-to-pay for the foregone alternative. Subject to some qualifications regarding unemployed resources, which will be dealt with at a later point, it is assumed that the total money value or costs of required project resources properly reflect the willingness-to-pay for the foregone resources uses.

Costs of resources used will include all direct expenditures required for construction as well as operation, maintenance and repairs throughout the period of project life. These consist of actual construction expenditures, transfers from other projects and interest during construction.

The value of resource uses displaced may be an important component in public water-related programs. For example, the costs of acquisition of a project site may reflect only the private market value of lands involved. If the site is in the public domain, or if privately held lands have a significant public goods component (scenic, scientific or recreational) then the actual acquisition costs may understate true social opportunity costs of the project. Also, certain cost-sharing arrangements may require local communities or beneficiaries to furnish lands, easements or rights-of-way. The appropriate opportunity cost measure of the value of such resources should be included in project resource costs.

Finally, in the case where plan output is in the form of an intermediate good (a commodity to be used in further production of final goods or services) the associated costs incurred in the process of converting the intermediate good to a final good must be accounted for. These associated costs are incurred by private sector users of plan output, but must be deducted from the value of gross plan outputs to properly obtain net beneficial effects. Examples of associated costs include production costs (machinery, labor, seed, fertilizer, etc.) of irrigated farmers receiving project water supplies, or perhaps the cost of conveying electric power from a hydroelectric power plant to final consumers.

B. External Diseconomies

In parallel with the treatment of external economies in the beneficial effect accounts, technological external diseconomies represent a real resource cost to the economy, and should be reflected as an adverse effect. (See Section IVC above for a definition and discussion) Uncompensated, undesirable side effects are measured in terms of the willingness of the adversely affected groups to pay to avoid the impact. For example, irrigation projects in the western United States often yield return flows (of excess irrigation water) which are high in dissolved solids due to concentration of existing salt loads or pickup of soluble soil salts. The impaired water quality may reduce the output of downstream irrigators or force household or industrial water users to adopt higher cost water treatment practices. The value of decreased production (in the first case), or the increased treatment cost (in the second case) represent the willingness-to-pay of the affected third parties to avoid damages.

C. Cost Adjustments for Utilization of Unemployed or Underemployed Resources

The general assumption underlying the analysis relating to the National Economic Development objective is that all resources are fully employed. However, this premise may not hold in certain regions or localities. Labor, fixed capital or natural resources can be unemployed or underemployed at specific times or places. A water-related plan or program may create opportunities to use resources which would be unemployed or underemployed in the absence of a plan. Such opportunities may be direct, in that the resources are used in construction, operation and maintenance of the project facilties, or the resources are employed in the utilization of intermediate goods produced by the plan. Alternatively, such opportunities may arise indirectly as a result of expansion of output by firms who do business with producers, resource owners, or consumers who are direct project beneficiaries or are employed on related activities.

In such a situation, the social costs of the increased output from the plan are overstated by the resource costs (i.e., wage rates). (The social opportunity cost should measure value in alternative uses, which is by definition in this case, zero or at least less than market price.)

Ordinarily, in theoretical discussions, unemployed resources are dealt with as deductions from program costs. However, problems arise in cost allocation procedures, and to avoid requiring beneficiaries to pay market rates (i.e., prevailing wage rates) for resources of low social opportunity costs, the

Principles and Standards require this adjustment be handled in the form of an addition to beneficial effects.

Measurement--The appropriate adjustment is measured by the difference in the earnings accruing to otherwise unemployed or underemployed resources with a plan as compared to their earnings without a plan. (Some analysts have argued that, in the case of unemployed labor resources, the supply price for labor should be used, rather than the earnings. The supply price would reflect the value of leisure, presumed to be greater than zero, rather than the earnings, which would be zero).

Because of measurement problems, this adjustment to the NED account is to be applied only for impacts during the construction or installation phases of a plan.

Special Topics

A. Optimal Scale of Projects

In practical applications, benefit-cost analysis of investment projects usually proceeds by analyzing specific, discreet projects or plans. It is well to keep in mind, however, that the quantity of resources elevated to a project can be regarded as a controllable variable, rather than a "requirement". That is to say that the scale of a project is not necessarily determined by physical factors, such as site characteristics, but is a matter usefully considered in the economic analysis.

Due to the existence of diminishing marginal utility of consumers (or diminishing marginal productivity for producers goods), the curve or function which relates total benefits to project scale will eventually reach a maximum. Also, the total costs will tend to increase at an increasing rate. These notions are illustrated in Figure 3, which assumes a single-purpose project. Note that in this example, total benefits is greater than total costs for a wide range of project scales, so an analysis of beneficial and adverse effects at any specific scale would find that benefits exceeded costs. However, the maximum difference between benefits and costs is found at a specific scale, denoted q* in the diagram. (This solution is found by the standard techniques of the calculus, putting the first derivative of the

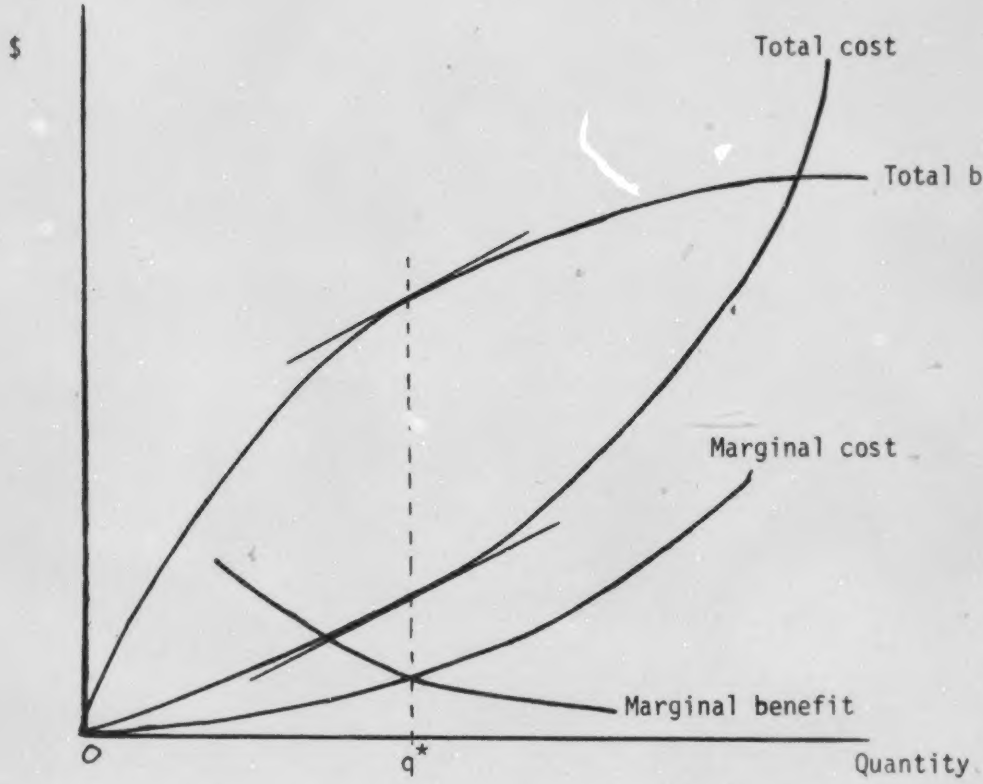


Fig. 3. Optimal scale of projects

net benefit function equal to zero and solving. In the conventional graphic approach of economics, this solution equates marginal benefits and marginal cost, as shown in the Figure).

B. Scheduling

Benefits and costs occurring over time are affected differently by the process of discounting when plans are examined according to alternative future time of implementation. Plan formulation should consider the alternative schedules of implementation to identify the schedule which would lead to the maximum contribution to the maximum present value of net beneficial effects. This point is of particular concern in instances where demand for plan outputs is growing at a relatively rapid rate.

This concept is illustrated in Figure 4. Construction at an early date (prior to t' on the graph), there is excess capacity, and demand (willingness-to-pay for projected outputs) is less than costs. Note that the present value of net benefits will be positive (or equivalently, the benefit-cost ratio will be greater than 1.0) at points in time beyond t'. However, due to rapid growth in demand, the present value of benefits will continue to rise if implementation of the project is postponed to a later date. On Figure 4, the time of implementation which yields the maximum net NED beneficial effects is shown by t*.

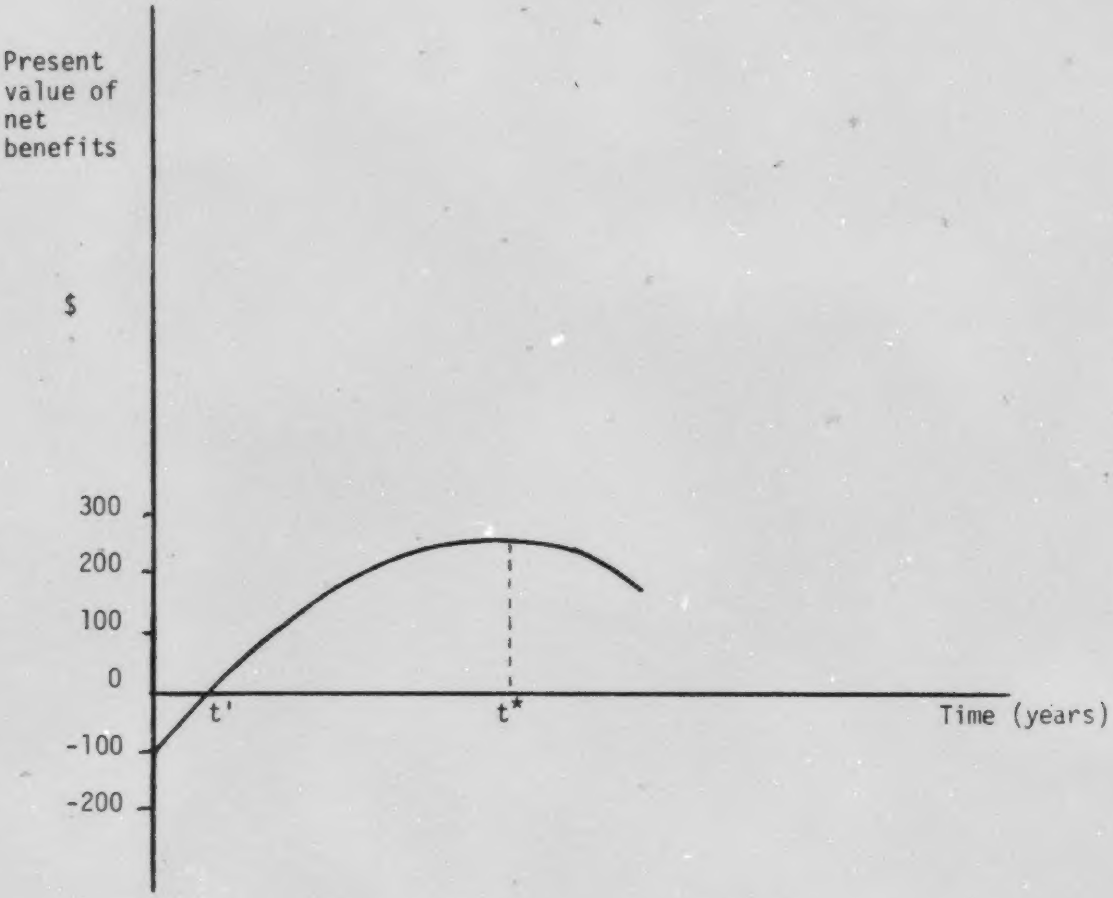


Fig. 4. Optimal scheduling of projects

THE ENVIRONMENTAL QUALITY OBJECTIVE

Ervin H. Zube
Director
Institute for Man and Environment
University of Massachusetts, Amherst

> "Plans for the use of the nation's water and land resources will be directed to improvement in the quality of life through contributions to the objectives of national economic development and environmental quality". (Principles and Standards (P&S), p. 5, Water Resources Council (WRC) 1973, p. 5).

Purpose

The purpose of this session is to provide an overview of the environmental quality (EQ) objective from a conceptual vantage point. The EQ objective is defined in the Principles and Standards as reflecting society's preferences so as,

> "To enhance the quality of the environment by the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural and cultural resources and ecological systems". (p. 6 P&S).

My comments are organized in four major sections. The first is a discussion of various concepts of the environment and of environmental quality which have been and still are extant in resource planning. The second section will address the EQ objective -- an interpretation of its breadth and constraints -- as it is presented in the Principles and Standards. The third section will focus on the techniques and devices suggested or implied in the Principles and Standards for the implementation or realization of the EQ objective. And the fourth section will present several approaches to the maximization of EQ in planning programs.

Concepts of the Environment and of Environmental Quality

What is the environment? In searching for an operational definition to use for this discussion I came across the following in a collection of readings on environmental planning prepared by one of the agencies that plays a major role in water and related land resource planning, the Office of the Chief of Engineers, Department of the Army (1970):

> "The environment of any living organism includes all things to whatever extent that they can affect or can be affected by said organisms. Factors such as soil, water, air, cities, plants and animals (including man and his culture); forces such as wind, tides, gravity and man's activities; conditions such as light, temperature, pollution and humidity; and processes such as photosynthesis, mineral cycling and decomposition constitute the complex known as the environment".

The definition ended with the admonition:

> "Note that man is both a factor and a force".

Environmental planning then is a process whereby the interactive and synergistic nature of the relationships between these factors, forces, conditions and processes are recognized as providing both constraints on, and opportunities for the realization of socially preferable resource management decisions. The environmental concern, as currently expressed and as inferred historically, relates to the end product of the planning or management process which contributes to or provides for the best possible "quality of life".

This is not a totally new concept in public planning. Significant examples of what today comes under the rubric of environmental planning and environmental quality concerns can be found for example, in the early efforts to create state and national parks in the nineteenth century -- preserving certain natural resources and ecological systems. This was an overriding concern in both the designation of Yosemite Valley as a state park in 1864 and the creation of Yellowstone National Park in 1872.

The Act which created Yellowstone stated that the area be:

> ". . . dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people . . .".

It further provided for:

> ". . . the preservation from injury or spoilation of all timber, mineral deposits, natural curiosities or wonders within said park, and their retention in their natural condition".

This concern with the preservation of natural resources and unique natural landscapes coupled with a concern for controlling resource exploitation was the major focus of the conservation movement which followed and gained momentum through the 1930's. Public concerns focused on the extremes -- on the preservation of the uniquely good and on efforts to ameliorate the effects of man as a force capable of creating misfits or uniquely bad environments, for example the cut-over forest lands of the midwest and the dust bowl of the great plains.

The first permanent federal legislation relating to air quality and water quality was enacted in the 1950's. The major thrust of the environmental movement, however, took place in the 1960's and 1970's. Increased legislative attention was focused on air and water quality and a host of new environmental concerns and programs were debated and launched. In 1966 the Bureau of Outdoor Recreation proposed a program for a nation-wide system of hiking trails and the Department of Commerce proposed a system of scenic roads and parkways. In 1968 legislation was enacted creating a national "Wild and Scenic Rivers System". These proposals were oriented to the protection or preservation of sections of the environment that were deemed to have social value in that they contributed to the general quality of life. They were environmental settings that provided opportunities -- directly or vicariously -- for quality environmental experiences.

In his Message to Congress on February 8, 1965, President Johnson stated:

> "We must not only protect the countryside and save it from destruction, we must restore what has been destroyed and salvage the beauty and charm of our cities. Our conservation must be not just the classic conservation of protection and development, but a creative conservation of restoration and innovation. Its concern is not with nature alone, but with the total relationship between man and the world around him. Its object is not just man's welfare, but the dignity of man's spirit".

In this message the President declared his support of proposed programs of scenic highways, trails and rivers but he also enumerated a long list of environmental ills that were urgently in need of attention.

On May 24 and 25 of 1965 a conference was convened at the White House in Washington, D.C. on "Natural Beauty". The program which consisted of fifteen individual panel meetings and a number of general sessions is most illuminating because it set forth an agenda of issues which were and still are central to our concern with the quality of the environment. The topical titles of the individual panels included: The Townscape, Parks and Open Spaces, Water and Waterfronts, The Design of the Highways, Scenic Roads and Parkways, Roadside Control, The Farm Landscape, Reclamation of the Landscape, The Underground Installation of Utilities, Automobile Junkyards and the New Suburbia. In addition, a number of panels focused on questions of institutional relationships necessary to initiate and effectuate action. The reports of the fifteen panel chairmen tended to address the environmental management issues in terms of development, protection and rehabilitation. Preservation as a mangement tool was suggested mainly for historic - cultural sites.

Since then, we have seen a number of legislative attempts to deal with environmental amenities such as the coastal zone and misfits such as billboards and surface mining areas. Concerns in the present session of Congress, for example, have focused on the need for rehabilitation of land areas subjected to surface mining for coal. Interestingly, in some parts of the country (e.g. the West) this reclamation activity which would demand considerable amounts of water for the re-establishment of vegetation, could become another major factor in the allocation of limited water supplies.

What is the significance of this all too brief foray into the history of the environmental movement? I think that it tells us a good bit about the concept of the environment that has been evolving and about changing concepts of a quality environment. Let me summarize the major ways in which our perceptions, values and/or program emphases have been broadened. They can be described along the five dimensions of: the parameters of quality, the environmental setting, the qualitative scale, the geographic scale and the management techniques.

1. The parameters of quality: From a primary focus on air and water quality and unique landscapes to an expanded array of natural and cultural indicators or characteristic exemplary of a quality environment.
2. The environmental setting: From concern with the management of natural resources in natural settings to the management of natural resources in all environmental settings ranging from wildlands through farmlands and suburbia to townscapes and cities.

3. The qualitative scale: From a qualitative concern with the uniquely good to a full spectrum of values including the misfit and the intermediate levels between the uniquely good and the misfit.
4. The geographic scale: From concern with individual sites such as unique geological features to the expanded geographic scale of natural systems such as wild rivers and to the environment as a continuum ranging from wildlands to cities which consist of overlapping and interacting natural and cultural resources.
5. The management techniques: From preservation as the primary management technique for environmental quality through protection and development to rehabilitation.

Assessment of Environmental Quality

This broadened perception of the environment has presented the scientist and the planner with a set of assessment problems which will be addressed in some detail at a later point in this program. There are, however, a few points relevant to the identification and assessment of EQ components which are particularly pertinent to the present discussion.

One element that has been explicit or implicit in all of the previously discussed efforts to provide for a better environment is that each proposed action was directed to the improvement of the "quality of life". As more and more programs were added, the lives of more and more people were impacted. As programs became more persuasive geographically, they began to affect broader and different sectors of the American population. Not only were the more affluent members of middle class society who frequented National Parks, for example, affected by resource management decisions advanced in the name of environmental quality; but also the lower income citizens who work in strip mines, who encounter roadside junkyards everyday of their lives or who work for river polluting industries. As a result of this broader impact and of heightened awareness of environmental resources in general, questions of values -- of the subjective dimensions of some of the environmental issues -- were recognized. Questions of what environmental characteristics are valued, and for what purposes and who benefits from programs directed thereto are exemplary. For example, should wildlife and related habit be preserved for aesthetic values only near a metropolitan center with hunting prohibited -- in effect catering to the bird watching public or should it be managed to provide for the alternate environmental values of another public and encourage hunting? Or should the water quality of a stream be improved to the level required for fish habitat or to the level required for contact sports? In both of these hypothetical examples it is unlikely that there would be considerable disagreement with the planners' efforts to provide objective measurement or assessment of the quality of the resource. There could, however, be considerable differences based on different "publics" perceptions of environmental quality and/or preferences for use. A stream or land area which does not provide for a preferred use may not be perceived as contributing to environmental quality, to the quality of life by those sectors of society whose preferences are not satisfied. In other words, resource quality may not be perceived as synonomous with environmental quality in all cases by all people. This potential for variable preferences and perceptions suggests that the following factors must be considered in the resource assessment process and in the development of the EQ objective:

1. Objective measures of resource quality based on empirical data.
2. Expert judgments of resource quality where empirical data are lacking.
3. User preferences for resource use.
4. User perceptions of environmental quality.

The first two factors are addressed to the question of resource quality. To the extent that the variables which are measured are responsive to changes and reflect the magnitude of those changes in some agreed upon critical component of the environment (e.g., open space, public health, aesthetic values, etc.), they may also be more broadly defined as EQ indicators. The second two factors relate to the questions of what variables or environmental characteristics should be measured. In other words, it is of vital importance that the issues addressed in the development of the EQ objectives be those that are recognized by the users, the several publics, as the issues of greatest importance. And, this speaks to the issue of public involvement at the earliest possible time in the planning process.

The Environmental Quality Objective

> "This objective reflects society's concern and emphasis for the natural environment and its maintenance and enhancement as a source of present enjoyment and a heritage for future generations".
> (emphasis added, WRC, p. 33).

> "Responsive to the varied spiritual, psychological, recreational and material needs, the environmental objective reflects man's abiding concern with the quality of the natural physical-biological system in which all life is sustained". (emphasis added, WRC, p. 33).

The caveats in these two statements relating to "natural environment" and "natural physical-biological systems" are appropriate and relevant, I believe, to a set of principles and standards for water and related resources planning. The central theme is resource planning and these terms help to define the natural resource domain. They should not, however, be interpreted to exclude metropolitan areas from consideration in this kind of planning. Natural environments, if we define them as environments consisting of primarily natural physical-biological systems rather than of cultural, socio-economic systems, can -- should -- and do exist in urban metropolitan centers. They are in fact - in the minds of many people - essential ingredients of any quality environment, be it rural or urban.

Environmental Quality Components

The Principles and Standards list four exemplary components of the EQ objective. They relate to: amenity values; cultural, educational and scientific values; resource quality; and maintaining options for the future.

The component relating to amenity values states:

> "Management, protection, enhancement, or creation of areas of natural beauty and human enjoyment such as open and green space, wild and scenic rivers, lakes, beaches, shores, mountains and wilderness areas and estuaries . . .".

While some of these resources such as mountains and wilderness areas are unique to or can only be found in natural settings, open and green space, lakes, beaches and shores are not. The planning and management of these resources in metropolitan areas can contribute significantly to urban amenities. The structuring of open and green space, for example, around natural drainage ways, around rivers and streams, can provide linear parks which thread their way throughout urban areas; which can serve as visual and physical means of structuring urban growth; and which thereby create and enhance aesthetic values. They can define boundaries and identify neighborhoods or sectors of the city. In summary, amenity resources should be considered along the entire environmental continuum, from wildlands to the city.

The component relating to cultural, educational and scientific values states:

> "Management, preservation, or enhancement of especially valuable or outstanding archaeological, historical, biological (including fish and wildlife habitat), and geological resources and ecological systems . . . ".

This component recognizes the importance of protecting examples of relatively undisturbed naturally occurring ecosystems for educational purposes and for scientific study -- for the maintenance of diversity in the environment and for use as benchmarks in assessing the impacts of man on similar ecosystems. It also recognizes the educational and cultural values society attaches to the buildings, structures, sites and other artifacts associated with the history and the prehistory of the land, the country and the culture. These buildings, structures, sites and artifacts are tangible examples of the values and actions which represent where we have been both as a nation and as individuals, and how we got to the present. They represent actions and artifacts of warfare as well as the accomplishments of community building. They provide insights to the evolution of its social and political insitutions and its scientific and technical developments.

The component relating to resource quality states:

> "Enhancement of quality aspects of water, land and air by control of pollution or prevention of erosion and restoration of eroded areas embracing the need to harmonize land use objectives in terms of productivity for economic use and development with conservation of the resource . . .".

This component addresses a broad topic. It speaks, for example, to the issue of non-point sources of pollution which are related to varying land uses and land use practices. It also speaks to the issue of relating use to resource capability. Considerations of steepness of slope, ground water level and soil quality for agricultural production are factors to be considered, both in controlling non-point sources of pollution and in harmonizing land use objectives with conservation of the resource. It suggests the consideration of resource capability analysis as a step in the planning process as a means of identifying the parameters of harmonious land use and conservation objectives. It also suggests that related land use -- a term which is not defined in the Principles and Standards -- be defined, for example, as the watershed in the case of a river basin study.

The component relating to the maintaining of options for the future states:

> "Avoiding irreversible commitments of resources to future uses: While all forms of development and use affect and sometimes change the tenuous balance of fragile aquatic and terrestrial ecosystems, the implication of all possible effects and changes on such systems is imperfectly understood at the present time. In the absence of absolute measures or standards for reliably predicting ecological change, these planning standards emphasize the need for a cautionary approach in meeting development and use objectives in order to minimize or preclude the possibility of undesirable and possibly irreversible changes in the natural environment . . .".

This component suggests that prudence be exercised in the allocation of resources when such actions approach the irreversible or make commitments that are irretrievable. It suggests, for example, that high groundwater yield and recharge areas, well sites, flood plains, prime agricultural land, wetlands mineral deposits and potential reservoir sites be preserved or limited in use such that those resource values are available to future generations even though their exploitation is not required to satisfy an existing demand.

The EQ Objective and Environmental Concepts

How comprehensive is the EQ objective as defined by the components? How does it measure up to the expanded concept of the environment discussed earlier? Five dimensions of this expanded concept were defined; the parameters of quality, the environmental setting, the qualitative scale, the geographic scale and the management techniques or alternatives. The EQ objective addresses each of these dimensions either explicitly or implicitly.

The parameters of quality are addressed explicitly and are in fact set forth as the four components. They range across a broad spectrum of natural, biological, and cultural resources which are assumed to be the critical parameters or indicators of EQ that can be addressed in a program of water and related land resources planning.

The environmental setting is addressed implicitly. The Principles and Standards specifies an emphasis on natural environments but they do not suggest that these natural environments only exist somewhere near the wilderness end of the environmental continuum. The parameters of quality delineated in the four components are found in metropolitan settings as well as in wilderness settings. Hence, concern with the full range of environmental settings along a continuum ranging from wilderness to urban is implicit.

The qualitative scale is explicit and ranges from misfits such as air, water and land pollution to high value amenity resources.

The geographic scale is explicit and includes individual objects such as a geological feature or an historical house to a region such as a watershed.

The management alternatives which are explicitly specified range from rehabilitation through development and protection to preservation. Thus, a full range of structural and non-structural devices are implied for the implementation of the EQ objectives.

Techniques and Devices for Implementation

Preservation refers to maintaining the status quo of highly valued cultural resources and relatively undisturbed natural systems as evidenced by an aggregation of existing objects or artifacts or by existing ecological processes. It suggests very limited constraints on use and requires primarily non-structural devices such as acquisition in fee or part.

Protection refers to the accommodation of limited change without loss of quality in critical environmental characteristics or parameters such as agricultural lands or open space and implies primarily the use of non-structural devices such as easements, purchase/lease-back, land use controls or tax incentives and subsidies.

Development refers to the initiation of change to provide some desired environmental characteristic or attribute such as the clearing of woodland to provide a view, building roads to provide access to environmental amenities or creating water bodies to enhance aesthetic qualities. It usually requires structural devices such as roads or dams and may also require non-structural devices such as acquisition.

Rehabilitation refers to the initiation of change to ameliorate misfits and to create or enhance environmental quality characteristics such as by reclaiming urban waterfronts from derelict structures or removing structures from flood plains to create water oriented open spaces and areas of natural beauty and human enjoyment. Rehabilitation can also require the use of both structural and non-structural devices.

This broad range of management alternatives, from preservation to rehabilitation and the related non-structural and structural devices, provides an effective means for addressing environmental quality components at essentially all planning scales and in all settings from wildlands to urban. The use of these alternatives and devices is also supplemented by a number of related congressional directives or public policies such as:

- The Wild and Scenic Rivers Act of 1968 (Public Law 90-542) which provides for the preservation of wild rivers and the protection of scenic and recreational rivers;
- The National Flood Insurance Act of 1968 (Title XIII, Public Law 90-448) which places increased emphasis on land use regulations in flood-prone areas;
- The Urban Growth and New Community Development Act of 1970 (Public Law 91-609) which calls for the preservation and enhancement of both the natural and the urban environment in new communities including new towns in-town and major additions to existing communities as well as free standing satellite communities;
- The Rural Development Act of 1972 (Public Law 92-419) which provides for the management of agricultural wastes, soil erosion and recharge of ground water; and
- The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) which establishes goals for waste treatment and water quality.

Such congressional directives can be interpreted as expressions of public values. As such they provide guidance in the identification of EQ components and in the identification of relevant techniques and devices.

Maximizing Environmental Quality

The fourth and final section of this discussion is intended to suggest ways of maximizing EQ. But, what factors contribute to the maximization of environmental quality in the planning process? This is an important, but very difficult question to answer. Obviously there are many factors which contribute both in discrete and in interactive ways but no single approach or factor provides the genius loci of the EQ objective. The following comments will summarize five of which I perceive to be the more important factors or ways. Some of the strengths and short-comings of each will also be noted.

The first factor for consideration is the importance of viewing the planning area as an environmental continuum rather than as a set of discrete, discontinuous sites. It is essential that resource planning programs be undertaken with a full knowledge of the implications of the previously stated operational definition of the environment -- the interaction between factors, forces, conditions and processes -- and within the broadened conceptual framework of the environment and environmental quality which has evolved during the past two decades.

Coincident with this view is the setting of the environment as the independent variable in the resource allocation equation. In other words, the capability of the component resources to accommodate varying kinds and intensities of human activities without loss of quality should influence the amount and nature of change to be accepted.

In the Southeast New England Water and Related Land Resources Study (SENE) this approach is being applied to obtain an approximation of the resource holding capacity of the region as an alternative to the Bureau of Economic Analysis (BEA) population and economic projections. All existing undeveloped lands were classified in one of three phases of an eliminative model. Phase I consists of critical resource zones in need of preservation which include water bodies, well sites, inland wetlands, coastal wetlands, critical erosion areas, beaches, anadromous fishing and spawning areas and shellfish flats. Phase II consists of highly valued resources and hazard zones which include potential reservoir sites and related watersheds, Class I and II agricultural soils and unique sites. Floodplains and coastal flooding areas are considered zones of hazard. Phase II consists of areas to be preserved or protected. Phase III includes all the remaining undeveloped lands which are then assessed to determine their capability to accept different intensities of urbanization. Factors used to assess capability include soils limitations for septic tank location, groundwater yield and recharge zones, scenic landscape quality, slope and wildlife habitat. Each of these factors was assigned a density figure on the basis of expert judgments reflecting the intensity of urbanization which it could accommodate with no loss in quality. In ten of the thirteen coastal drainage areas which make up the SENE region the resource holding capacity was greater than the BEA projected growth, in two it was less and in one the same. Overall it suggested that capacity was greater than the projected 1990 growth.

This is a very useful tool for environmental quality planning but it is also an incomplete one. Resource values are based on empirical data where available and where necessary on expert judgment. As such, it strives for a high degree of objectivity. There are several short-comings or problems that should be recognized in its use. It does not include consideration of the public's preferences for varying life styles and varying perceptions of related quality environments which are manifest by rural, small town, suburban and urban settings. If resource capability were to be the primary EQ planning factor, it could result in a regionally homogeneous environment supportive of limited variations in life style. It may also, as a recent critic stated, become accommodation planning, "under which growth is assumed and the only question becomes how to accommodate and distribute it". (Conservation Foundation, 1974, p. 7). Another problem is that of the variable quality of the resource inventory data used to develop the capability analysis. The data are usually assumed to be of equal quality, particularly in reference to the spatial distribution and locational aspects, regardless of the sampling or other inventorying procedure employed. An unjustified precision and specificity is usually imputed to these data.

The second important factor in maximizing environmental quality then is the identification of the "publics" environmental preferences and perceptions of quality. As already indicated, these preferences and perceptions may not and probably will not be consonant with an objective assessment of resource capabilities to accommodate change. The Principles and Standards are explicit in reference to the importance of this factor throughout the entirety of the planning process.

The third factor that can contribute to the maximization of environmental quality is the identification of priorities for action. Criteria which were developed to address the question of environmental quality priorities in the North Atlantic Regional Water and Related Land Resources Study (NAR) for example related to:

1. Areas and resources with the highest probability of loss or diminution of quality because of existing or impending pressures for development and change, areas that are sensitive to qualitative change in the immediate future.
2. Areas and resources nearest to those "publics" most in need of enhanced environments because of sub-standard existing environments or because of limited access to environmental amenities and quality experiences.

The fourth factor relates to the identification of the best techniques and devices for the realization of the desired EQ benefit. The Connecticut River Basin Supplemental Flood Management Study (CRBS) for example, is recommending a non-structural alternative for flood control as the one which is most supportive of the "publics" preferences and perceptions of quality, an alternative which emphasizes preservation and protection of existing qualities. This option is explicitly recognized in the Principles and Standards which state " . . . consideration may be given to an alternative which explicitly precludes any significant forms of physical construction or development. Where such a 'no development' alternative is considered, it must be recognized that positive action is nonetheless required to assure that the 'no development' concept can be realized . . ." (p. 103). The positive actions under consideration for the no development alternative in the Connecticut Basin will be selected from the following:

- Subsidized insurance
- Compulsory insurance
- Emergency relief
- Flood warning and forecasting
- Emergency evacuation
- Complete acquisition
- Partial acquisition
- Flood plain zoning
- Cluster zoning
- Wetland laws
- Building codes
- Subdivision regulations
- Encroachment regulations
- Urban renewal

- Control of utilities
- Flood proofing

It is likely, however, that techniques and devices which are selected to maximize the EQ objective in one area will not be the best choices in another area. They will be related to the publics' preferences and perceptions as they vary over space and time.

The fifth factor that contributes to the maximization of environmental quality is the identification of those actions, techniques and devices which are complementary to and supportive of both the EQ and the national economic development (NED) objectives. To the extent that this is possible, trade-offs between EQ and NED are minimized.

In summary, I have discussed five of what I think are important factors or ways in which environmental quality can be maximized in resource planning programs. I think that it is obvious, however, that it is not a matter of selecting one or two, but rather of applying all. The five factors are:

1. Conceptualizing the environment as a continuum and as the independent variable in the planning equation;
2. Identification of the "publics" environmental preferences and perceptions of quality;
3. Identification of priorities for action;
4. Identification of the best techniques and devices; and
5. Identification of actions, techniques and devices which complement and support both EQ and NED objectives.

Summary

In the course of this discussion I have touched briefly on four major themes or areas of interest related to environmental quality and resource planning. The first was the delineation of a much broadened concept of the environment which has evolved over the past two decades and which has been manifest in congressional mandates and public policy. The second was my interpretation of the environmental quality objective as set forth in the Principles and Standards. The third area that was discussed was the techniques and devices which are both explicit and implicit in the EQ objective. The fourth and final theme or area of interest was a sampling -- hopefully a critical sampling -- of ways of maximizing environmental quality in the planning process.

The themes were broad and as a result, time did not allow for much more than a general review in any one area. I did, however, try to probe the edges of the areas of interest rather than the center wherever possible. In other words, I am more interested in assessing the apparent latitude of action that is possible under the new Principles and Standards than I am in defining a set of precise, sharply defined components, techniques and devices. I find boundaries which are defined as zones more attractive than boundaries that are defined as lines.

From this frame of reference, it seems to me that the Principles and Standards can be interpreted as a marvelously broad and flexible set of guidelines for undertaking water and related land resources planning. The environmental quality objective provides the latitude for dealing with a diverse array of factors, forces, conditions and processes which impinge -- directly and indirectly on the quality of life over a range of geographic scales and environmental settings. From my vantage point, it would be unfortunate to interpret the document in a narrow, precise manner.

The fourth component of the EQ objective is addressed to avoiding irreversible decisions. This admonition might be applied equally well to the early interpretation and application of the Principles and Standards. Let me close with an often used quotation from one of my geography colleagues in the resource management field: "There are times when ambiguity hath its charms". In other words, the Principles and Standards have to be broad enough to cover the three levels of planning and the considerable difference in environmental considerations to diverse planning regions across the nation. To accommodate this breadth and diversity as well as retaining the flexibility to encompass emerging planning technologies and environmental assessment techniques, and when a general document is applied to a specific region and set of issues, a certain amount of ambiguity is to be expected and should be desired.

References

Conservation Foundation (1974) "Carrying Capacity Analysis is Useful but Limited", Newsletter, June.

Department of the Army (1970) Perspectives in Environmental Planning, Washington, D.C., Office, Chief of Engineers.

Fabos, J.G. (1971) "An Analysis of Environmental Quality Ranking Systems", Recreation Symposium Proceedings, USDA Forest Service and Syracuse University College of Forestry, New York, p. 40-55.

Thomas, W.A. (1972) Indicators of Environmental Quality, London Plenum Press.

Water Resources Council (1973) "Water and Related Land Resources Establishment of Principles and Standards for Planning", Federal Register, Washington, D.C., September 10.

REGIONAL DEVELOPMENT (RD) AND SOCIAL WELL-BEING (SWB)

Robert Gidez
Vice President, Program Development
INTASA, Consultants, Alexandria, Virginia

This paper focuses on the Regional Development (RD) and Social Well-Being (SWB) accounts specified in the Principles and Standards. The purpose is to (1) explain the role of the RD and SWB accounts, (2) summarize specification of the accounts, (3) present problems of including them in the evaluation process, and (4) indicate a process of implementation.

The implementation process discussed here is based on identification of important effects related to water resource programs. Measurement of RD and SEB effects is further discussed in Topic Group IV of the Manual.

Role of RD and SWB Accounts

The Principles and Standards, superceding Senate Document 97, represent a definite change from past resource planning. They call for systematically relating all aspects of water and related land resources planning to economic and environmental planning criteria upon which plans may be formulated and subsequently justified; where appropriate, effects on regional development and social well-being will be assessed and displayed. The purpose of this session is to discuss the latter type of assessments.

The RD and SWB accounts do not represent formal objectives, but are included in the Principles and Standards to allow consideration of important issues that might not otherwise be manifested in the National Economic Development (NED) and Environmental Quality (EQ) accounts. In a recent publication, the Director of the Water Resources Council stated:

> "As the Principles and Standards are written now, formulation of alternative plans will be based on national economic development and environmental quality objectives. Basically a recommended plan must have net economic development benefits except where the deficiency in net benefit results from benefits foregone or additional costs incurred to serve the environmental quality

> objective. In other words, a plan with no net economic benefit could be recommended if it has overriding long-term environmental benefits.
>
> Also there is a provision of the Principles that says a department secretary or agency head may make an exception to the net economic benefit rule if he determines that the circumstances unique to the planning and formulation processes warrant an exception. What this means is that under unusual circumstances it is possible to go forward with a plan that does not have net benefits under either of the objectives. Obviously, the economic development and environmental quality objectives make up the significant accounts; however, beneficial and adverse effects on regional development and social well being will be displayed where appropriate to give further assistance to the decision maker." (See Reference 2).

The RD account is intended to identify ways in which a water resource plan may "exert a significant influence on the course and direction of regional development" (Ref. 1, p. 76). The types of effects, or "components" of the RD account, as stated in the Principles and Standards are: regional income, regional employment, population distribution, diversification of the regional economic base and environmental conditions of special concern. Furthremore, it is stated that since there are major difficulties in estimating some components of the RD account, a complete display of effects for all components is not to be attempted unless so directed by a department secretary or head of an independent agency.

The SWB account is intended to display the effects resulting from the interactions between the inputs of a plan and the social and cultural setting in which these are received and acted upon. The primary concern is the equity of the distribution of real income, employment and other social opportunities which result from the plan. As with the RD account, major methodological difficulties are acknowledged. In this case, however, more emphasis is placed on the need for planners to explore innovative approaches to the identification and measurement of effects. Finally, it is stated explicitly that in cases where appraisal of the effects is relevant to the proper evaluation of a plan, the measurement standards to be applied in the SWB account "must necessarily be broad and variable."

Present Specification of the RD and SWB Accounts

Since the RD and SWB accounts are loosely defined compared to the two objective accounts, it is important that attempts to incorporate them into the planning and evaluation process be based on a good understanding of what is and is not specified in the Principles and Standards. A detailed review of each account is therefore warranted, which is discussed in Topic Group IV (Measurement) of the Manual. However, the type of questions asked in this review is of interest in order to understand the perspective of the present Principles and Standards.

1. What specific effects are to be captured within each account component? Clear delineation of the effect is a necessary prerequisite towards determination of the indicator appropriate to measure the effect.
2. What specific indicator(s) are suggested in the Principles and Standards to measure the effect?
3. What methodology is prescribed for measuring the indicator, i.e., what steps does the planner/evaluator have to follow to obtain the indicator value?
4. What type of additional comments are made to facilitate directing the measurement process?

Although it is realized that publication of generally applicable Principles and Standards in the Federal Register does not allow for detailed discussion of all intricacies involved in measuring RD and SWB effects, the following observations can be made:

- There appears to be a difference in the degree of sophistication with which each account component is approached. The most clearly defined indicators are those in the RD account, particularly for the income and employment components. In the SWB account the distribution of income is most specific in terms of the measure (real income in dollars). However, like all the SWB components, it lacks definition of how the distribution is to be considered, stating simply that the benefits and adverse effects accruing to "designated persons or groups" are to be assessed.
- Both accounts lack definition of what constitutes a "significant" effect that should be measured in the evaluation of a plan.

Guidelines would be desirable so that consistent choices are made by planners. Clarification of what is important would help insure that major effects are not ignored, and that time and effort are not wasted in determining inconsequential effects.

- No suggestions are given for developing a display procedure, other than stating the need to show the indicator measurements described for each component. At best the Principles and Standards identify where quantification is possible, and where qualitative and descriptive material is to be the only feasible source of information. There is no discussion at present of what type of information is required by what interest groups or decision makers for the various planning studies. In this regard, there is no indication of differentiation with respect to the nature or level of detail for assessment required for the various planning levels.
- It appears that even in a general framework such as the Principles and Standards, more detailed or more appropriate indicators can be developed for some of the components. For example, an acceptable standard for regional economic stability should be within the present state-of-the-art. Similarly, additional measurement methodologies could be identified for different components, or references could be made to the appropriate body of knowledge.

In conclusion, the Principles and Standards establish useful guidelines for the assessment of RD and SWB effects, but generally do not specify the procedures to be followed.

Implementation Problems

Where the previous section presented an account of RD and SWB assessments in summary form, the purpose of this section is to formulate the main problems that can be anticipated in using existing Principles and Standards. It is necessary to surface such problems in order to proceed in an orderly fashion with development of procedures for their implementation. The following seven problem areas have been identified and are discussed in this section.

- Consistency of the account system.
- Completeness and significance of components in the RD and SWB accounts.
- Relationship between account components and water resource systems.
- Standardization of specific measurement methodologies.
- Data sufficiency.
- Display.
- Operational constraints.

A. Consistency of the RD and SWB Accounts

The main concern in this problem area relates to the requirement for any account system to clearly indicate what different account components are intended to measure. Ambiguity should be minimized so as to prevent cases where multiple interpretations of the Principles and Standards are possible or cases where it is not clear from the outset what the measurement objective entails. This is illustrated by the following examples: (1) There is some fuzziness in the present Principles and Standards between the role of the RD and SWB accounts and the display requirements for the NED and EQ accounts. The Principles and Standards state, "the distribution of beneficial and adverse effects will be shown to whomsoever they accrue. This will include display of the distribution of effects to regions, income classes and interest groups relevant to the particular plan and will reflect ... cost information..." (Ref. 1, p. 18). It is not clear to what extent the display of information for the NED and EQ accounts is to include distribution effects, or if the RD and SWB accounts completely fulfill that role. (2) As indicated in the Principles and Standards to assess the adverse effects on regional income, consideration should be given to "Losses in output in the relevant regions resulting from resources displaced and subsequently unemployed" (Ref. 1, p. 77). It is not quite clear what the scope of measuring entails in this particular case. Is the above an "all-resource-encompassing" statement or does it address human resources in particular?

In conclusion, it is important that the purpose of each account be fully understood, if the selection of account components, indicators, methodologies and display is to be useful. Resolution of inconsistencies necessary for the development of procedures can be achieved by further interpretations of the accounts as they appear in the Principles and Standards. For example, the RD account is directed towards measuring aggregate regional effects with the emphasis on the comparison between regions. In addition, there has to be consideration to the range of complementary programs other than water resources required in the region to realize the full potential of the water programs. By contrast, SWB is directed towards the distributional issues which makes disaggregation of impacts a necessity. It shares with RD the need to assess the role of nonwater programs in enhancing or inhibiting water related impacts.

B. Completeness and Significance of Account Components

The main concern in this problem area is twofold: (1) to determine whether the account components as presented in the Principles and Standards cover the complete spectrum of effects and (2) to determine the significance of the effects presented. In order to assess whether or not a given account is complete, a critical survey of past studies regarding the impacts of water resource systems with respect to the account components is needed. Examples of such studies are found in Cox (Ref. 3), Tolley (Ref. 4), Gaffney (Ref. 5) and Howe (Ref. 6). At present, there seems to be no strong tie between the components presented in the Principles and Standards and actual case histories that can be used to make this type of judgment.

An example of a potential completeness problem is found in the SWB account, where the entire account is structured into components that represent "separable classes of social effects" so as to facilitate understanding of the effects. This may not be completely true, however, since recent studies have shown the importance of focusing on major links between total community well-being and water resource programs (Ref. 7 and 8). The effects that result are aggregate in the sense that they represent a change in the overall status of the community, and are best described as such. For example, it was found in Reference 7 that the future success of a Model Cities Program depended on the development of new housing. The major portion of available land lay in a flood plain and would not be developed without flood protection. In that example, the impact of the flood control project could not satisfactorily be represented by simply stating the effect on housing development. The significant effect is the potential overall improvement of the community through the success of the Model Cities Program. Thus, there would appear to be a need to recognize an additional component related to total community impacts. This would be included under "Other" by the local planner.

Guidelines for determining the significance of account components are presently not in the Principles and Standards. They should be established so that planners can focus on the essential parts of the assessment problem and disregard the rest. The guidelines might take the form of relative differences either among the components or with respect to regional baseline conditions. For example, income effects might have to be a minimum percentage of average regional income levels before distribution effects are significant enough to display. A start in this direction has been made in cases where "significance" is interpreted in Federal agency guidelines as "material" bearing on the decision-making process" (Ref. 9, p. A-3). More specific definitions of significance are needed however, and should be based on actual water resource program planning experience.

C. The Relationship Between Specific Account Components and Water Resource Systems

One way in which planners can be assisted in selecting significant components for evaluation is to identify relationships between account components and the various types of water and related land resource programs. Thus, if a planner is concerned with a regional wastewater management program, attention can focus immediately on those account components most likely to be affected by that type of program. The Principles and Standards can be augmented to show significant relationships between account components and particular programs. It is conceivable that such relationships would have to vary by region of the country, so that for example, irrigation or recreation projects in the Southwest United States show up as having significant impact on regional agricultural income while they might not do so in the Northeast United States. In conclusion, by attempting to link the effects to be assessed to the type of level of programs under consideration, the application of the Principles and Standards requires more specific descriptions of indicators, available methodology and display requirements.

D. Standardization of Specific Methodologies

Since the Principles and Standards are to provide national planning guidelines, it is essential that the recommended methodologies be generally applicable nationally. There are two considerations in this regard. One is that methods have to be specified to the extent that they are applicable for a set of problems which although belonging to the same category have slightly different characteristics. For example, economic stability analysis of navigation projects in the Northeast might differ considerably from those in the Plains States because of greatly different economic structures in each region, however, the same basic methodology may be applied. The second consideration is with respect to the level of detail for which methodologies should be developed for the different type of planning studies addressed by the Principles and Standards. For example, input-output modeling may be very appropriate for Implementation Studies (Type C), however, the level of detail required to conduct a meaningful regional input-output study may be far too much in a Framework Study (Type A). To determine which methodologies are to be standardized, it will be necessary to assess existing analytical tools in terms of their general applicability as well as in terms of the type of planning studies for which they are most suitable. Such an assessment would be similar in nature to that of Reference 10 where the requirement for general applications of certain methods are discussed.

E. Data Sufficiency

In conjunction with the previous problem area, a clear delineation has to be made of the account components for which data are available in a standardized form. It is those components whose indicators can be measured by standardized methodologies. The example given earlier of utilizing input-output models apply here also, since it would be necessary to know if the detailed input data and technical coefficients are generally available either by region or nationwide before a method can be recommended. One important consequence of data availability for the development of procedures is whether or not the indicators can be quantitative or have to be qualitative. Dependent on this outcome, the development effort may take a completely different direction.

F. Display

The display guidelines now contained in the Principles and Standards simply indicate that the benefits and adverse effects should be shown in whatever terms can be used to represent them. There are at present no indications of the interest groups who will have to be shown the information. However, in order to provide direction to the planning and decision making process more emphasis is to be given to the form of communication. Effective communication is selective and concentrates on major achievements rather than on complete enumeration of all project effects. Thus, one of the main problem areas relates to guidelines for display in the RD and SWB accounts. An important element of these guidelines should be consideration of *how* the display can be selective and can concentrate on major issues.

G. Operational Constraints

The Principles and Standards are to be implemented by a wide range of agencies and institutions. Therefore, consideration has to be given to developing procedures that are suitable for the capabilities of those groups in terms of the number and skill level of their personnel, and the availability of data. The procedures selected by WRC have to be realistic in terms of the ability of the performing agencies. Again using input-output analysis as an example, there would be little value to recommending such a procedure for small local planning agencies lacking (1) experience in its use, (2) the computers needed for efficient handling of data and computations, and (3) a comprehensive data collection. In that case surrogate procedures such as Keynesian multipliers might be recommended for a given size and type of planning group. A discussion of such an alternative is found by Bromley in Reference 11. There is a need then to tailor the assessment needs to the existing capability of agencies and institutions.

Implementation Process - Part One

The purpose of this section is to describe a process by which the planner/evaluator can identify the "significant" effects of a proposed water resource system. The discussion does not consider the techniques by which the effects can be measured. The Measurement papers of this conference will deal with the available measurement techniques and the need for new methods in the RD and SWB accounts, respectively. The basic question guiding the development of this section is:

- Within the scope of the present Principles and Standards what are the effects to be assessed for the different types of planning studies?

In answering this question it is important to note two considerations:

- At the national level WRC is concerned with improving the Principles and Standards and developing procedures for their implementation.
- At the regional and local level, planners have to work with the available Principles and Standards and methods to conduct the needed planning and evaluation.

In most cases common problems exist, such as determining what is a "significant" effect. In other cases, such as the application of methodologies, recommended procedures do not always make the application feasible. The material needed by the planner/evaluator is a list of important "system-effect" combinations for which qualitative or quantitative procedures can be identified or developed. The information required to develop such a list consists of (1) a description of the effect capturing concerns regarding RD and SWB and an indication of its significance, and (2) a description of how the effect is linked to the various water and related land resource development systems or programs. An example of a "system-effect" combination is: regional income linked to a system of levees for flood protection. Guidelines for the significance of this which the increased regional income represents. In addition to linking the effects to particular development systems or programs (flood control, water quality, etc.), the list is further differentiated in terms of the different levels of planning studies. Generally this will entail, for implementation studies, a larger degree of detail in the "system-effect" combination than would be needed for framework studies. The following efforts will be necessary.

A. Grouping of Effects

This provides for a logical structure that can encompass all specific effects relevant to RD and SWB, thereby capturing the complete spectrum of concerns which the RD and SWB should address. Since each of the accounts has a different function, they are treated separately.

1. Regional Development

As discussed previously, the intent of the RD account may be stated as measuring aggregate regional effects with the emphasis on the comparison between regions and between a region and the rest of the Nation. To capture the range of concerns related to this objective, the following grouping is proposed to provide a comprehensive structure.

- Economic Viability. This assessment is concerned with the short- and long-term position of the regional economy relative to other regions or the rest of the Nation. The following components and their indicators relate to particular concerns: regional income, regional employment, and regional economic base and stability.
- Social Viability. The main thrust is to determine the competitive advantage of the region relative to other regions as a place to live and work. The component relevant to this group of concerns is population distribution, including urban rural balance.
- Environmental Viability. This assessment relates to the region's natural ability to absorb development associated with water resource systems. This ability is to be contrasted with those of other regions.

This structure is based on the premise that all issues or concerns regarding regional development can be described be delineating their economic, social or environmental aspect. The above grouping brings out an important requirement imposed on the assessment process, namely, to assess by means of indicators how a water and related land resource development program affects the economic, social or environmental viability of the region. Thus, indicators are not ends in themselves, rather, they are means to an end. As a result, the choice of indicators can be judged in terms of how well they perform this basic role.

2. Social Well-Being

As discussed earlier the prime emphasis in this account is on measuring distributional consequences of water and related land programs on the people in areas affected by the program. To capture all concerns in this regard, a structure is proposed which allows for differentiation of distributional consequences in terms of basic characteristics of people's life: income, opportunities, security and hazards. Thus, concerns can be classified dependent on whether they affect:

- The income the different segments of the population receive.
- The opportunities in education, culture and recreation that are open to segments of the population.
- The security for life, health and safety that is provided to different segments of the population.
- The hazards to which different segments of the population are exposed and their level of preparedness to respond to an emergency.

Clearly, in the above an attempt is made to deal with social well-being in terms of aspects that together make up a concept like "quality of life." Grouping concerns according to these aspects will provide a meaningful classification, making the assessment of SWB effects easier. As stated earlier, the emphasis is on identifying the nature of the groups receiving benefits or adverse effects. The definition of such groups is crucial. This might be geographical or, as discussed earlier, by community; by nongeographic factors such as income, race or age; or by a combination. For procedural development, guidelines are needed for selecting the breakdown for different communities. For example, in the Southwest, emphasis might be given to the cultural impact on the Mexican Americans. In other areas, a breakdown by income might be more important. A checklist of common major issues should be prepared at the national level to demonstrate what is needed.

B. Investigation of Linkages

After grouping concerns, the second major effort in the process is to determine what effects are related to what type of water and related land resource programs. For example, local flood protection might not have a significant effect on regional income, but there may be a strong tie to enhancing the social viability of the region. Thus, in this part of the effort the emphasis shifts to the various purposes of water and related land resource development and to an attempt to link them to the previously identified effects. For each type of planning study addressed by the Principles and Standards, linkages can be classified in two groups:

- Those that occur with all water and related land development purposes.
- Those that occur only with particular purposes.

This classification simplifies the problem of a planner having to identify the important linkages for a particular study and select a methodology to carry out the analysis. At the national level, it would be desirable to investigate linkages for the different type of planning studies and develop a list of "system-effect" combinations for each type of planning study. This list could then be used to focus the development of required methodology. Figure 1 illustrates such a list, showing how each individual water resource system has several major linkages to the RD and SWB components.

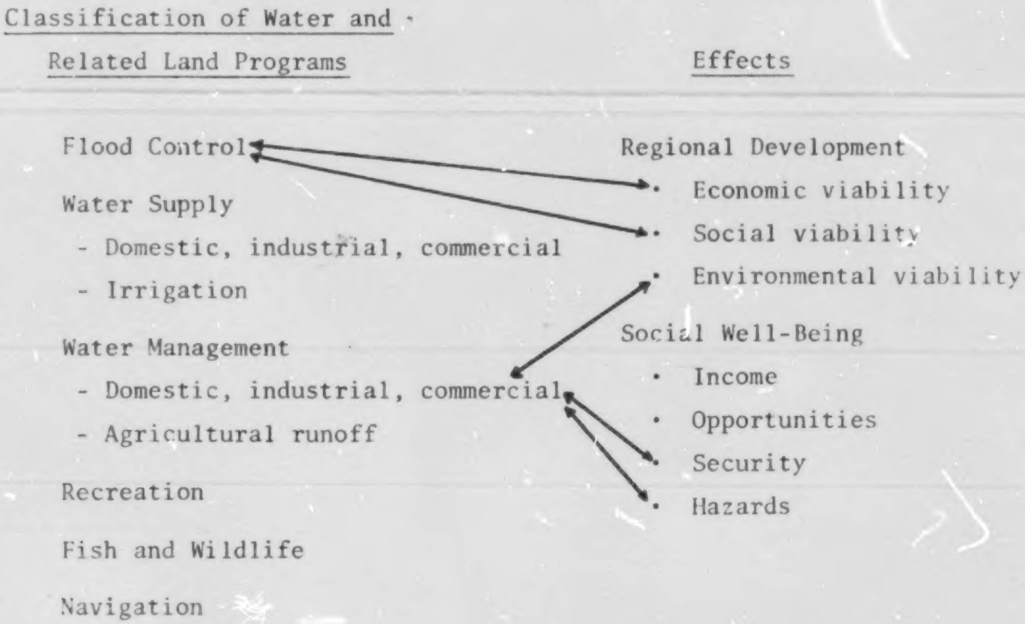


Figure 1 Example of Linkages

Although the emphasis here is on a systematic classification of major linkages, it is realized that it may not always be possible to keep such a clear picture of the relationships for two reasons. One is that the significance of the linkages will vary as a function of project location, size and relation to nonwater programs in a region. For example, flood control may be important for strictly economic reasons in one case, but may include social reasons in another as in the example cited earlier. The second reason for a complex and changing set of linkages is that the water resource programs of concern will employ different combinations of purposes. Depending on the combination being considered, the linkages of a particular program may be very important in one situation but not at all important in another. For example, if a program includes water supply and wastewater management in one case, and water supply and flood control in another, the importance of water supply could be very different in the two cases. This would be true if flood control is a dominating factor in the second case, but wastewater management was a minor concern in the first case.

The above underscores that at the national level the investigation and classification of linkages has to be flexible enough so as to portray variable situations while at the same time it should serve its basic purpose, namely, to facilitate methodology development. One of the first steps in establishing a useful linkage description is to determine which of the situation characteristics are to be included, such as location, size of the project, and the types of systems considered. At the regional and local level, the planner/evaluator has to use the available guidelines to the extent they help focus on important effects and appropriate methodologies.

Conclusion

- The Principles and Standards leave a great deal undefined in the RD and SWB accounts
  - effects to be measured and the indicators to be used are not specified in detail.
  - methods are generally not specified, but the SWB account is in most need of methodology development.
- Implementation of the Principles and Standards in these two accounts would be facilitated for the planner by focusing on the identification of system-effect combinations. With the list as a guide, the planner can estimate the magnitude of the various effects and determine which are "significant" and must be included in the full evaluation of alternative programs.
- At the national level, such a focus could be developed for a range of study levels, and the types and setting of programs. This would provide (1) improved guidelines for the planner in

determining the significance of effects and in selecting available measurement and analysis methods, and (2) direction of efforts to improve methods.

References

1. "Water and Related Land Resources; Establishment of Principles and Standards for Planning:, Federal Register, Vol. 38, No. 174, September 10, 1973, pp. 1-169; 1-13.

2. Fairchild, W.D., "2 Objectives, 4 Accounts", Water Spectrum, Vol. 5, No. 4, 1973, pp. 22-27.

3. Cox, T.P., C.W. Grover and B. Siskin, "Effect of Water Resource Investment on Economic Growth", Water Resources Research, Vol. 7, 1971, pp. 32-38.

4. Tolley, G., Symposium on the Economics of Watershed Planning, Knoxville, 1959, sponsored by the Southeast Land Tenure Research Committee, the Farm Foundation and the T.V.A., Ames, Iowa State University Press, 1961.

5. Gaffney, M.M., "Benefits of Farm Programs", American Journal of Econ. and Soc., 26: 236-30, 417-24, JL-0, 1967.

6. Howe, C., Water Resources and Regional Economic Growth in the U.S. 1950-60, Johns Hopkins Press, 1968.

7. INTASA, Socioeconomic Impact of Flooding on Community Development in North Richmond, Final Report prepared for City of Richmond, California, June 1971.

8. INTASA, A Comparative Analysis of Alternative Land Use Patterns for the Omaha Area, Final Report prepared for U.S. Army Corps of Engineers, Omaha District, Omaha, Nebraska, July 1973.

9. Planning Guidelines for Assessment of Economic, Social and Environmental Effects of Civil Works Projects, Office of the Chief of Engineers, Department of the Army, Regulation No. 1105-2-105, Washington, D.C., December 15, 1972.

10. Bergsman, J., et. al., Research on Urban Economic Development and Growth Policy, Urban Institute Report 200-5, Washington, D.C., February 1972.

11. Bromley, D.W., "An Alternative to Input-Output Models: A Methodological Hypothesis", Land Economics, Vol. 48, No. 2, May 1972, pp. 125-133.

ECONOMIC PROJECTIONS

Henry L. DeGraff
Bureau of Economic Analysis, Department of Commerce
and
William A. Green
Economic Research Service, U.S.D.A.

The ultimate beneficiaries of resource management programs are people. When we plan for the development and management of water and related land resources we are planning for the use of those resources by people in their homes, in recreational activities or in the production of goods and services. As planning is initiated, therefore, extensive information about prospective future economic and population conditions is necessary. Plan formulation and evaluation are fundamentally a projective process.

The Principles and Standards for water and related land planning specify that "plan formulation and evaluation shall be based upon national and regional projections of employment, output and population and the amount of goods and services likely to be demanded." The standards go on to specify the OBERS Projections as a base for the Council's current views as to probable rates of growth in populations, GNP, employment, productivity and other factors.

Our objective therefore is to discuss the use of the OBERS projections in Multiobjective Planning to meet the needs for water and related land in the multiplicity of uses made of them by our society.

To accomplish this objective, it is necessary to discuss the OBERS projections program, and to relate the projections to multiobjective evaluation and accounting. The material that we will be sharing with you is related specifically to the role and use of projections in generating estimates for the NED and RD accounts. But, economic projections are also required for both the environmental and social well-being accounts, and we note with approval that one section of this program is concerned with environmental projections. Land use data systems and projections generated by the OBERS program constitute a partial interface between the OBERS projections of economic activity and efforts to project environmental conditions.

The OBERS Projections Program

As a prelude to our discussion of projection issues, we offer a brief overview of the OBERS projections, primarily for those who lack extensive experience with the OBERS program and reports. We acknowledge, of course, that a great many water planners and analysts have an understanding of the OBERS program and a keen awareness of the problems of using the OBERS reports in multiobjective planning.

Scope

The OBERS program is made up of three elements. The first is a regional information system which consists of a historical data base covering the Nation and including income, employment, agricultural and forestry production, and population. Uniform economic measures were developed for each metropolitan area and county of the United States. Uniform data sources and methods of estimation were employed in constructing the area measures. The data base, then, is consistent from area to area and over time. Because of its county building blocks, the data can be assembled in almost any geographic configuration required.

The second element of the program is the projections. These are a nationally consistent system of economic and demographic information relevant to future program decisions. National consistency and systematic information generation are characteristics to be stressed. The projection system retains the same elements of consistency as the data base.

The OBERS projections are derived by economic rather than demographic methods. The historical data series measures the activity in each of the several industry groups and portrays the growth trends in the industry's regional contribution to national totals. The aggregate economic growth of each region is determined by the mix of basic industries in the region and their potential for growth. Population is regarded as a function of income and employment. Patterns of interregional migration reflected in the projections, therefore, are determined by the employment opportunities rather than by the continuation of the migration rates of some historical period.

The third element of the OBERS program is special analytical systems designed to evaluate the economic impact of water resources and other public investment programs. Much developmental work remains to be done on this element of the program to arrive at the complete interregional system. However, progress is being made and one partial model is already in operation.

The three elements of the program are closely interrelated. The projections stem from the data base and form the baseline framework for the impact evaluation.

The OBERS Reports

There are now two sets of projections entitled the 1972 OBERS Projections. The first--the five-volume set with the blue and white covers --was published in the fall of 1972. The second--a seven-volume set with red and white covers--will be distributed in October. The main difference between these two sets of projections is the assumption about national birth rates. In the first set the total fertility rate was assumed to be 2,777 births per 1,000 women. In the second, it was assumed to be 2,111 per 1,000 women. The latter rate will eventually yield a zero population growth. The two assumptions are respectively related to the Census Bureau's "C" and "E" series of national population projections.

At the time the decision was made to use the "C" series as the basis for the first set of projections, it seemed most realistic to the majority of population experts. However, for the past several years the birth rate has been at the zero population growth level.

There are other differences between the two sets of OBERS projections. The use of more recent data made it possible to eliminate some of the disruptive effects of the Vietnam conflict. Changes in the national assumption about productivity and hours worked per man per year are in line with more recent research. Minor changes in methodology were made to improve the population projections.

It is expected that in the near future the WRC will adopt the series "E" projections as the baseline.

Industrial and Geographic Detail

The industrial and geographic detail of the OBERS projections have a great significance in their use.

It frequently appears that, within each area, population is the only dimension of the projections of which the potential users are aware. And yet the industrial detail, which is necessary in making the projections, is also needed by water resources planners and analysts. Water use -- both withdrawal and consumptive -- and land use vary widely among industries. When the projections are used as the framework for project and program impact analysis, the industrial detail is essential. Many users would like more detail than is shown in the OBERS report. Efforts are underway to generate greater detail in the future. This will include the age and income distribution of the population as well as more industrial detail.

The "E" series report will include data for the 173 BEA economic area, the water resources regions and subareas, the States, 253 SMSA's, and the non-SMSA portions of the economic areas and water subareas. Data have already been distributed for the aggregated subareas of the National Assessment.

Further disaggregations of the projected data can be made under special circumstances where a local sponsor can arrange for review of the data by persons knowledgeable of conditions pertaining to the local area's economic activity.

Uncertainty

A major problem in using any projections for decision-making arises from elements of uncertainty. Even in the ten-year life of the OBERS program, substantial changes have been introduced as new developments and events have been reflected in the OBERS data base.

Differing orders of reliability characterize the various elements of the projections. These differences are caused by variations in the length of the projection period, the size of the aggregate being projected, potentials for product substitution, and many other factors. Levels of reliability for the projections cannot be stated in statisical terms. They can only be evaluated qualitatively with the results interpreted in light of the uses to which the projections will be put. A general understanding on the part of the user of the degree of reliability associated with any projections should help avoid misinterpretation and inappropriate use.

Potential errors in the planning process growing out of errors in the projections cannot be eliminated, but their effect can be reduced by using sensitivity analysis, maintaining flexibility in the development plan in order to accommodate revised projections at future dates, and updating the projections at periodic intervals.

The Baseline Concept

The explicit assumptions and the methodology of the OBERS programs have been described in numerous meetings and in Volume 1 of the OBERS reports and should be familiar to most of you by now. In using the projections in multi-objective planning, an understanding of the baseline concept is necessary.

The OBERS projection program was inaugurated in connection with the Type I Framework Studies. Economic impact and benefit-cost analysis were not required in those studies. "Needs for development" were derived from the OBERS projections. The objective, in general terms, was to satisfy requirements at minumum cost -- or at least effectively. This same approach was followed in the first national assessment and in the Type II studies, although in the latter case benefit-cost evaluations were made for "early action" program elements. But even in these cases, the relationships between the OBERS projections and the required benefit-cost ratios were not explicit.

The "baseline concept" was articulated and advanced as an alternative to the requirements approach. The basic intent of the baseline is that the OBERS projections be utilized as an economic framework and as reference points for economic impact and benefit-cost evaluations. The Principles and Standards provide a convenient accounting system for these evaluations.

Two characteristics of the OBERS projections facilitate their use as the baseline. First, they represent "best estimates" of the future in the absence of unusual or unforeseen changes in the policies, programs and economic forces that shape the changes in economic activity. The fact that they are best estimates simplifies the measurement problems in the evaluation by bringing the starting point close to reality. Second, because the projections are based on trends established by supply and demand forces of the "market place," and because they are nationally consistent and balanced, they are considered to represent an economy approaching equilibrium condition. This approximate equilibrium condition is important in establishing an integrated interregional impact evaluation system.

The baseline projections, then, are a starting point in planning and a framework for evaluation.

The Continuing OBERS Program

Before beginning our consideration of the use of the OBERS projections, a brief word about the ongoing developmental work will be of interest.

Work is continuing on the economic impact evaluation system. This system uses the projections as the baseline and seeks to measure the interregional generation and displacement effects of projects and programs. Funding in BEA is in prospect to start work on multi-regional input-output, including the interregional trade flows, which will facilitate the completion of this system. Usable results will be obtained only after several years of work. In the meantime we have made operational a regional impact multiplier system which provides industry-specific input-output multipliers for any county or group of counties. This model will be discussed during the regional measurement session on Wednesday. In addition, we have made progress in developing a primary effects model for industries which are sensitive to access to markets and to sources of supply.

Another project of interest is underway. ERS, in conjunction with Iowa State University, is developing a linear programming model that will generate national-interregional agricultural projections and test the sensitivity of regional production patterns in response to changes in water and land availability, per capita consumption, exports, and other variables.

Other work is underway to strengthen the data base for more analytical application of the agricultural projections system. Improved production cost and land productivity data are prime examples.

Looking to the future, a continuing OBERS program is being developed by a special WRC Work Group. The program being formulated will be responsive to the needs arising from the adoption of the Principles and Standards. Continuing efforts will be expended in designing projection systems which will permit the testing of alternative assumptions in regard to such factors as energy supplies and prices, and environmental constraints. We expect future OBERS program developments to generate a framework of information and a system of analysis that will make possible the resolution of issues that cannot be resolved at this time.

Use of Economic Projections in Evaluation

Economic and demographic projections, as outlined in the OBERS reports, serve three general purposes in water and related land resources planning. First, they serve as a primary basis for projecting future demands for water and related land. Second, they may be used as indicators of the nature and magnitude of emerging economic problems in an area. Third, they provide a useful structure of future economic relationships for evaluation purposes. When used in the evaluation process, the OBERS projections serve as reference points from which program induced effects are approximated.

General Viewpoints and Concepts

A long-standing and widely accepted construct of benefit-cost and economic impact analysis, which is incorporated in the Principles and Standards, is the "With" - "Without" principle where benefits are defined as the difference between two situations or scenarios -- "With" and "Without" the development being studies -- at common points in time. Quantification of the "With" -"Without" situations, however, has proven to be an elusive goal of benefit-cost practitioners for many years. The OBERS projections may provide a more suitable basis for "With" -"Without" analysis than has been available heretofore. Or, with the OBERS projections, it may be possible to generate valid estimates of the difference without establishing the precise magnitude of either. However, at the regional level, categorical statements cannot be made as to whether the OBERS projections represent a "With" or "Without" condition. The OBERS projections, as previously noted, are based on extensions of historical trends without explicit consideration of usable water supplies. They incorporate the implicit assumption that the necessary supply of water and related land resources can be developed without changing the relative regional marginal costs of production. Hence, the "With" - "Without" question must be pursued through additional analysis to ascertain the economic growth shown in the OBERS projection. In more specific terms, special analyses are required to ascertain the extent to which the projected levels of economic development can be realized in the absence of further water resource development.

The procedure for determining the "With" - "Without" nature of the projections consists of converting the projections to requirement quantities of water and related land resources and then comparing the sum of the various quantities with the developed supplies for the area.

The first iteration at this transformation would most probably use current local area water use coefficients for the various categories. In later iterations it may be in order to estimate economic demand schedules for water based on an analysis of the economics of its use as influenced by changing technology and shifting values in various uses.

If the projected requirements exceed developed supplies (the "With" condition), supply augmentation would be investigated. If requirements do not exceed supplies (the "Without" condition), two options may be considered. First, if the projected baseline economy meets the objectives of the people of the area in question, further development would be unnecessary. However, even though the initial analysis shows that the projected supplies of water and related land are adequate to sustain the projections, consideration may be given to further development where production efficiencies may be gained or where accelerating regional economic development is desired and may be enhanced by water development.

When the projections represent a "With" condition, an early step in the evaluation process must be a determination of the "Without" development situation for each purpose. The Principles and Standards require that beneficial and adverse effects of a proposed plan be measured by comparing the estimated conditions with the plan with the conditions expected without the plan. The Standards state that:

> "Since economic, social, and environmental conditions are dynamic, changes will occur without the plan in a variety of factors, including regional economic activity, rates of unemployment or underemployment, and environmental conditions. Consequently, only new or additional beneficial and adverse effects resulting from the proposed plan should be attributed to it."

Even though the projections represent a "With" development condition, the expected situation for some purposes without the development under consideration will not differ from the situation portrayed in the OBERS projections. This will occur in areas and for purposes for which the private sector or local government will undertake the development in the absence of the Federal project being considered.

A series of charts will illustrate the "With" versus the "Without" situation in different circumstances and will also show the relationship between the OBERS projections and the origin of the benefits arising from changes in employment or income.

Figure 1 illustrates a situation where the economic activity will be the same with and without the project and the OBERS Projections accurately represent that activity. In this case there would be no NED or RD benefits from an induced change in economic activity. Benefit estimates for either the NED or RD accounts would be based on economic changes or adjustments not directly related to the OBERS' projected measures of economic activity; i.e., the benefits from resource development would arise from internal improvements in efficiency, from reduction in damages from water surpluses or shortages, from beneficial shifts in patterns of consumption, or from locational shifts within a community or region. Most M & I water supply, water-based recreation, urban flood control, and many navigation projects, for example, fall in this category. This estimation of this type of benefit also applies under circumstances described in Figures 2, 3, 4 and 5.

Figure 2 illustrates a case where the economic activity "Without" the project would be restricted to a lower level than portrayed in the OBERS Projections. In this case, most NED benefits arise from the difference in economic activity between the "With" and "Without" condition. But, as the chart indicates, the difference between the "With" and "Without" situation is only a partial basis for determining NED benefits. An interregional analysis of marginal costs would indicate the efficiency gains to be included in the NED account and would determine the offsetting effects in other affected regions.

Figure 3 illustrates a case where the OBERS Projections represent the "Without" situation but where it has been determined through an interregional marginal cost analysis that the most efficient level of production in the project area with development would exceed the OBERS Projections. Part of this increase in production would be cancelled out by displacements in other areas.

Figure 4 represents a variation of this same situation. In this case, the OBERS Projections represent a "With" condition which is less than the level of most efficient production. Again there will be interregional transfers of production which will partially offset the gains in the project area.

Figure 5 illustrates a case where the OBERS Projections are a "With" situation, but only part of the increase in economic activity can be efficiently met by the development. This will results in increased production in other areas with no project benefits.

The OBERS Projections have frequently been assumed to be the maximized NED level of development. Figures 3, 4 and 5 illustrate why this is not so. When a development is justified in terms of national economic development, it should be scaled to maximize the benefits whether the level of economic activity equals, exceeds, or falls short of the OBERS Projections.

The interregional analysis is illustrated in Figure 6, which shows the supply curves for individual regions and national supply and demand curves. As the supply curve in region 1 is driven downward to the right by a project or program, the national supply curve is also shifted

Figure 1. Region A. OBERS Projected Economic Activity, "With" and "Without" Conditions Identical

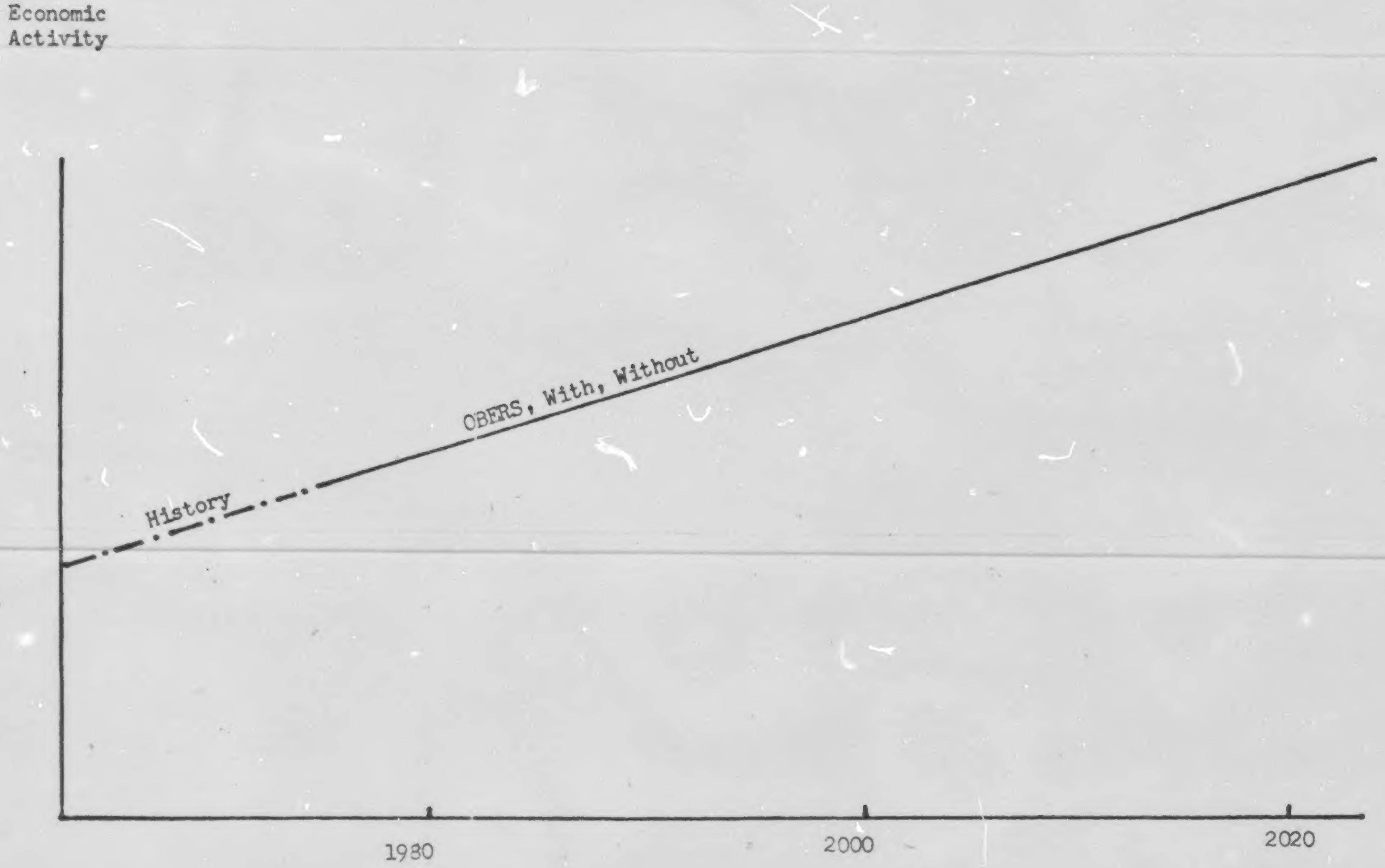


Figure 2. Region B. OBERS Projected Economic Activity Equals "With" Condition.

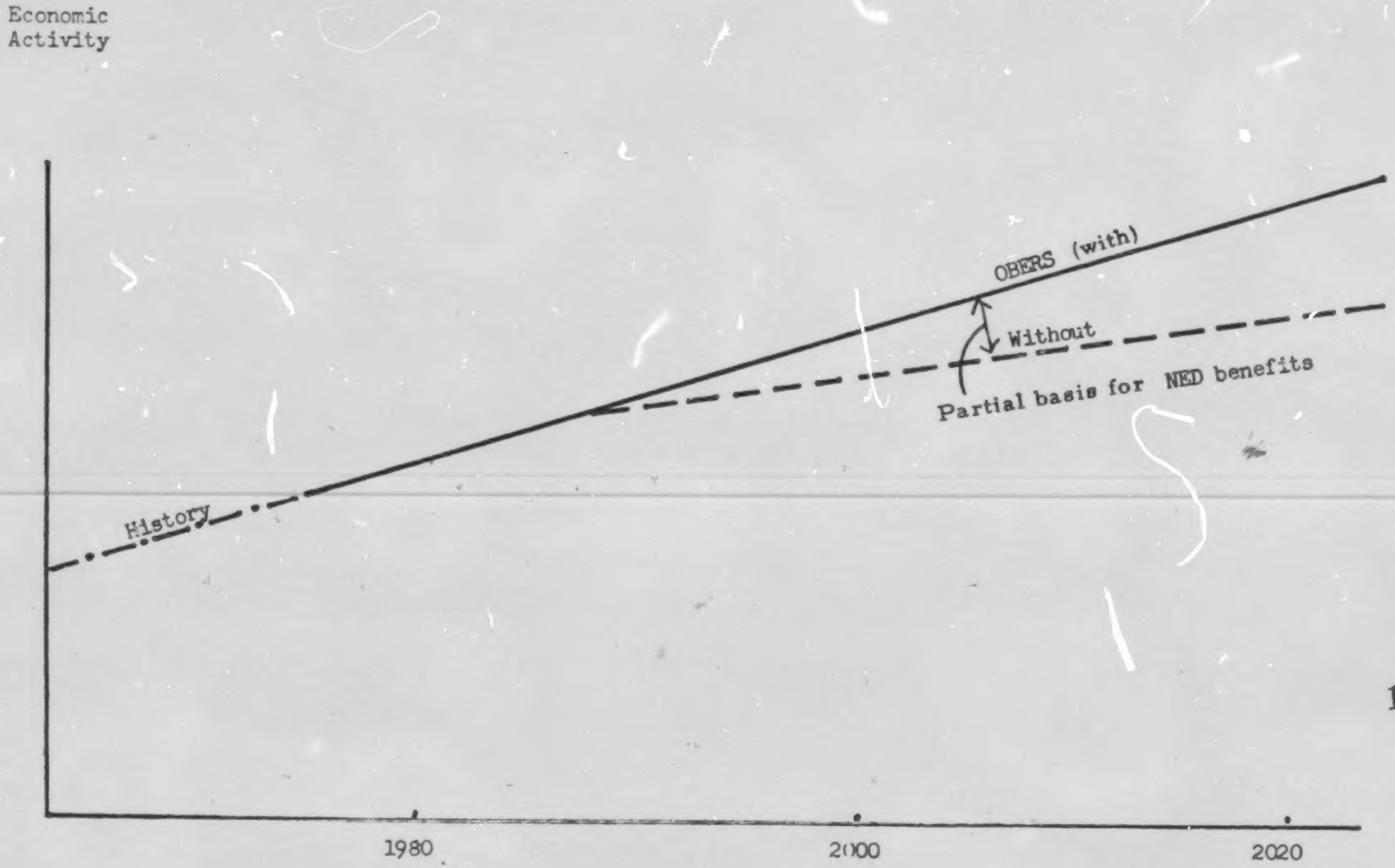


Figure 3. Region C. OBERS Projected Economic Activity Equals a "Without" Condition.

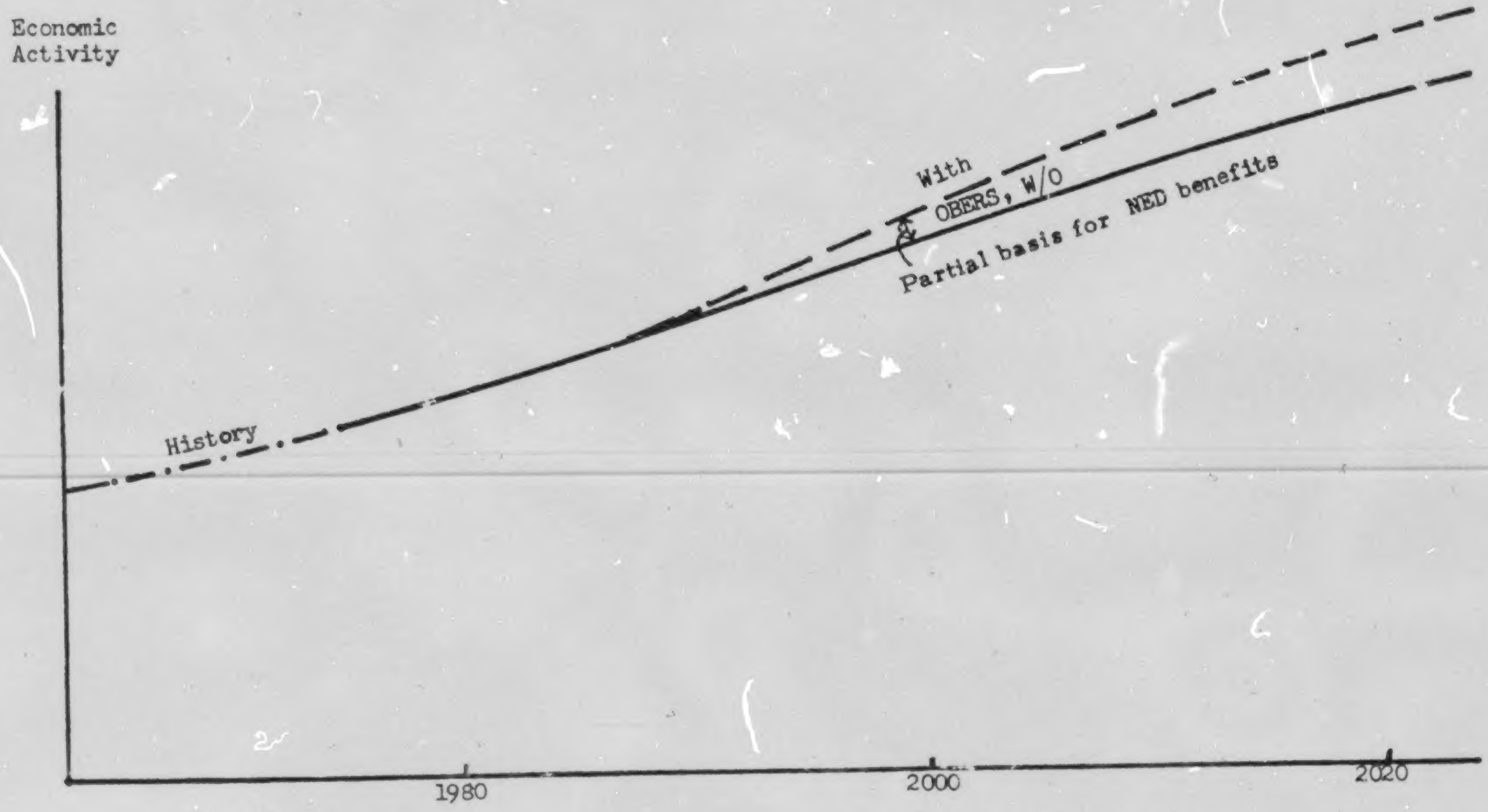


Figure 4. Region D. A Variation of Figure 7 With OBERS Projection Falling Between the "With" and "Without" Conditions.

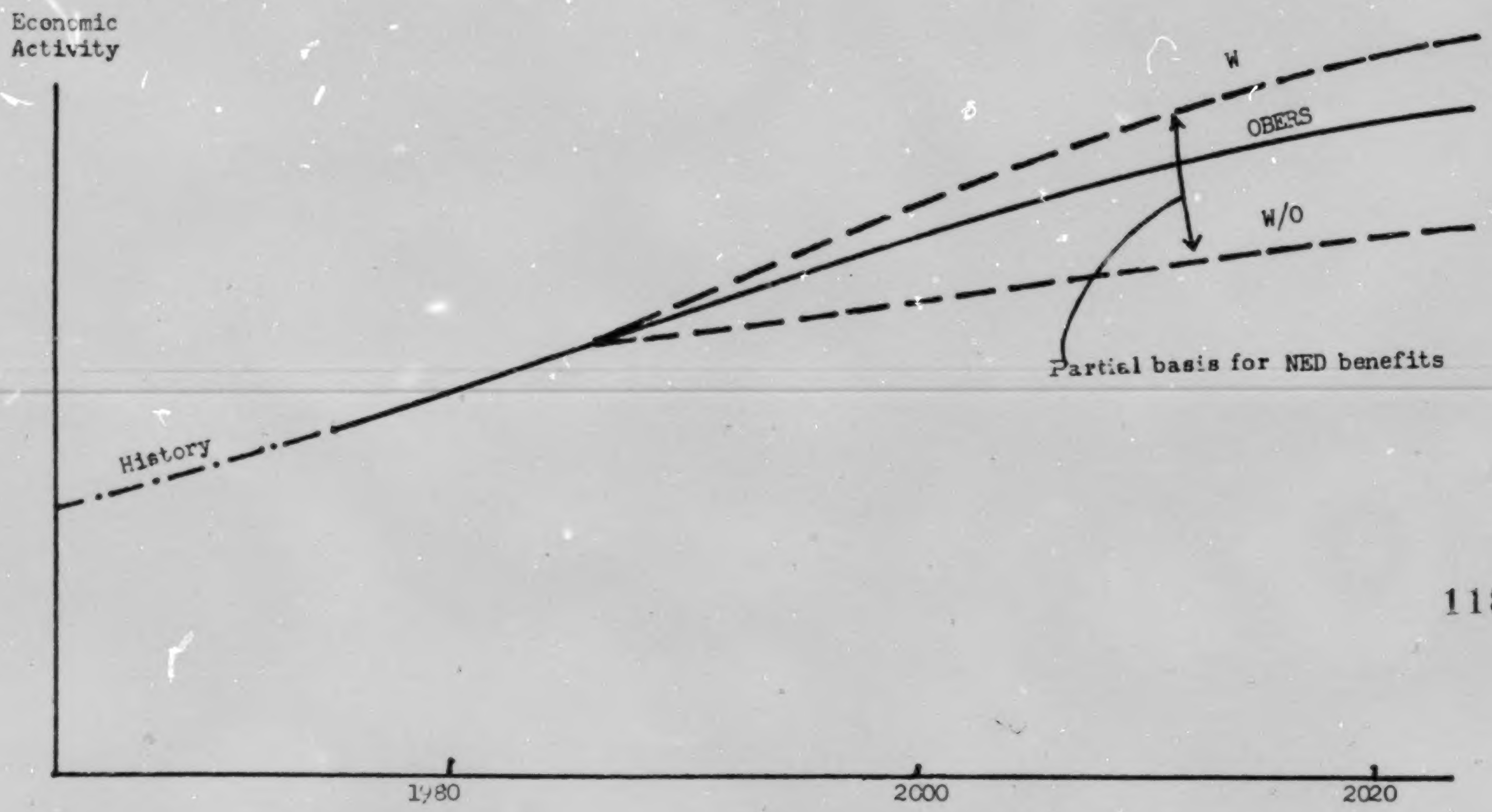


Figure 5. Another Variation of Figure 7 with the OBERS Projections Above Both the With and Without Condition.

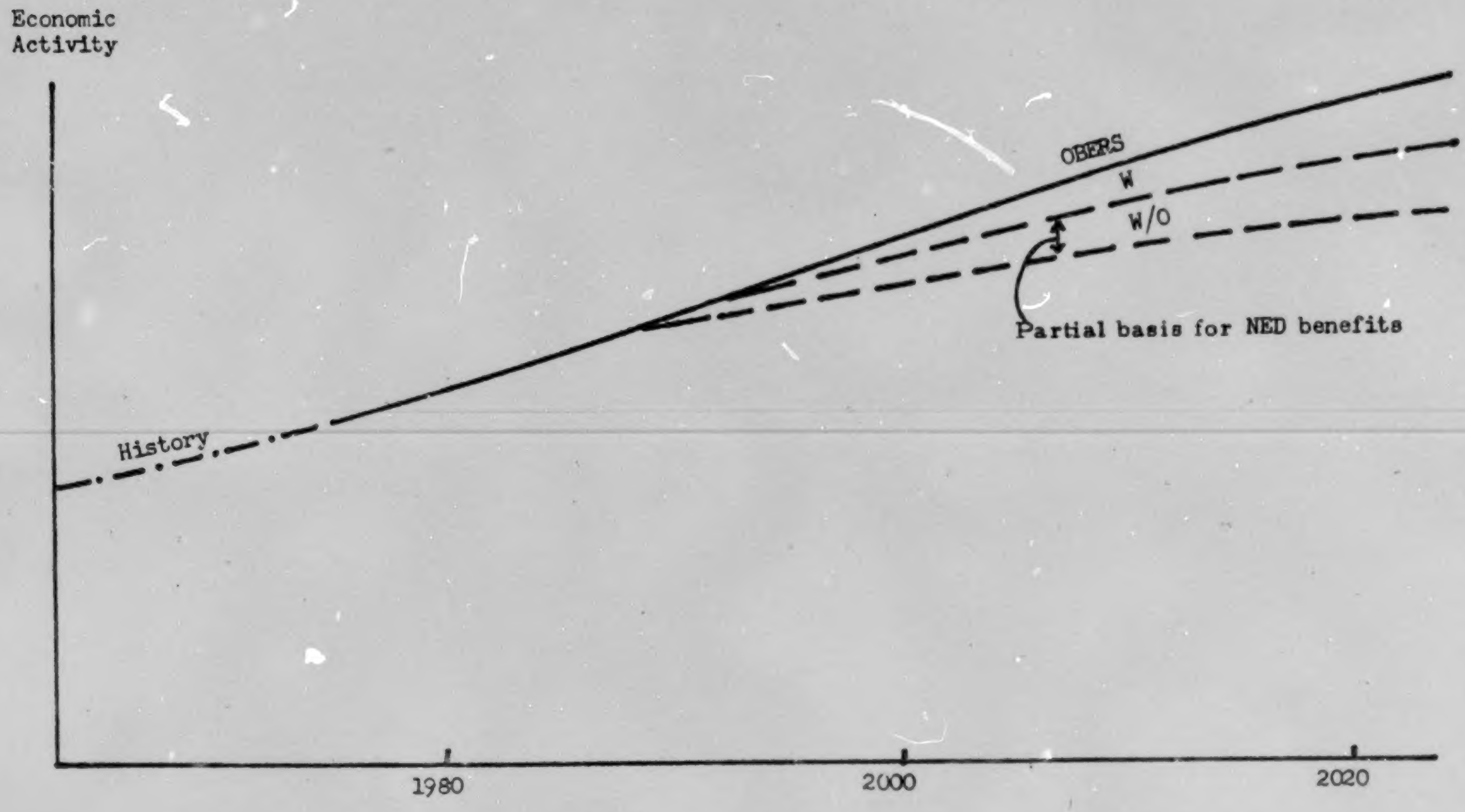
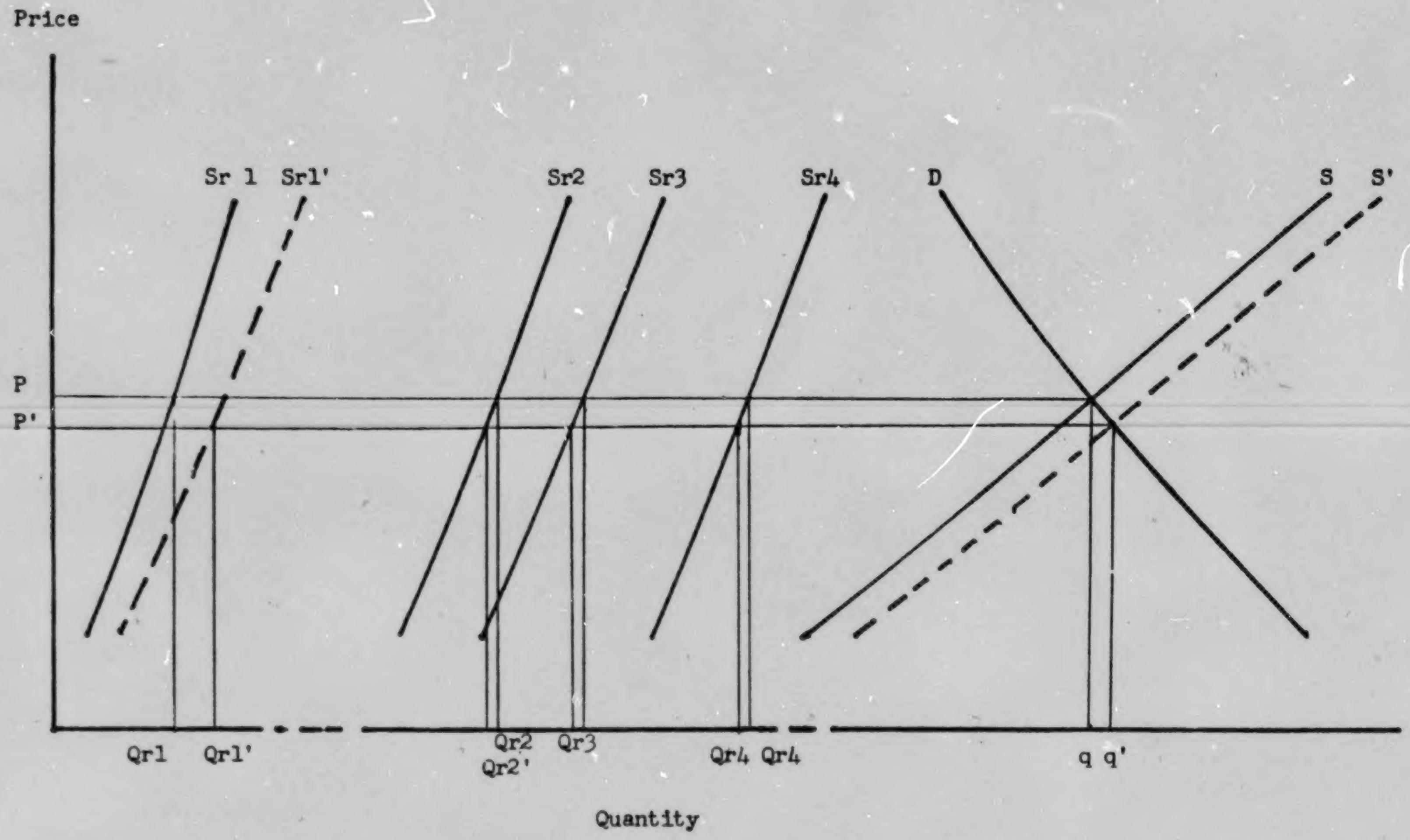


Figure 6. The Aggregate and Regional Effects of Increasing Production Efficiencies in One Region



downward to the right and a new price is established, representing a shift in marginal unit costs. In response, each region shifts its production to the point where the new price intersects the regional supply curve. Time is of course required before equilibrium is re-established.

National income changes of two types (NED benefits) arise from the induced shift in marginal costs and prices. First, a direct increase in national output results. Second, the "Without" level of output is achieved at a lower level of input use. Resources released by this process are available for other use, thereby creating an indirect source of national income gain. The treatment of these induced changes in the M.O.P. accounting system are discussed later.

The regional incidence of the changes in output and the use of economic resources is also illustrated in the chart.

A Case Illustration

The use of projections in evaluation may be illustrated by a hypothetical case where the projected economic growth is constrained by the availability of usable water supplies. In other words where the "With" and "Without" conditions are different.

In the assumed case, typical of many river basin areas in the Great Plains and Western regions, water is used for a variety of commercial purposes, with use for agricultural production commonly dominant. In the various uses the per unit contribution of water to economic development varies widely. The distribution of limited supplies among competing uses is determined in part by economic forces, and in part by physical and institutional barriers to beneficial shifts in water uses. Key questions are: (1) If water supply is not modified, what is the likely response of basic water-using industries in terms of input use and resultant output? (2) What are the indirect consequences of these basic industry changes to supporting input industries, to the processing and transportation sectors, to the residentiary industries, and to the demand for capital improvements and services provided by local government? (3) What are the induced effects in competing areas? The desired evaluation for the study area, shown in aggregate terms, is depicted in Figure 2.

The use of projections in this case involves an estimation of the patterns of water use with the OBERS projections of economic activity and an assessment of usable surface and ground water supplies. The suggested procedure rests heavily on professional judgment in estimating how water supplies will be allocated among competing uses under conditions of aggregate shortage.

The procedure is illustrated in Exhibit I. This table provides for two levels of economic development and associated patterns of water use: (1) A baseline condition, i.e., the OBERS projections without water supply constraints; and (2) a "Without" condition in which water use is in balance with usable supply. If, for a given projection year, usable supply is equal to or in excess of aggregate use, there would be no difference between the two parts of the table.

Key points in the suggested analysis are: (1) The estimates of the modifications in per unit water requirements, if any; and (2) the distribution or reallocation of restricted supplies among competing sector or subsector uses to bring projected total use into balance with total usable supply. A logical basis for the allocation is the estimated marginal values of water among competing uses, subject to the provisions of existing compacts and other legal barriers to beneficial adjustments in water use.

Exhibit 2 is a summary table showing the level of output by sectors for three water supply conditions, the "Without" condition and the baseline condition, both of which are derived from Exhibit I, and a condition with assumed supplies of water greater than for either of the other two as depicted in Figure 8. The third condition is highly conjectural in that it implies a competitive advantage for the area being studied over that depicted in the OBERS projection. It is included in the illustration in recognition of agricultural land constraints reflected in the OBERS agricultural projection, which could be relaxed with additional irrigation development. The illustration may also apply to energy supply developments.

Exhibit 2, it should be noted, provides for estimates of employment and total population associated with the different levels of economic activity.

How may the values derived from this analysis be used in the accounting system provided by the Principles and Standards? Concerning the NED account, it should be noted that the distribution of production among regions is different for each of the three conditions depicted in Exhibit 2. With the higher levels of usable water supplies, production resources otherwise employed in competing areas are shifted to the study area. The higher levels of production are counterbalanced, in whole or in part, by compensating adjustments in other areas.[1] The "Principles and Standards" as we interpret them leave some latitude as to how these shifts in production and the shifts in the location of resource use are to be entered into the M.O.P. accounting system.

One possibility is to show the negative effect in competing regions as an external diseconomy. Increased economic activity in the related sectors of the economy in the project region, and counterbalancing effects of a similar nature in competing regions, would be accounted for in the same manner. To determine a change in national income, an estimate of efficiency gains and/or other net locational advantages is required.

A second possibility is to account for the higher level of input use in the benefited areas as "associated costs," either as a deduction from the gross value of output or as a cost entry in the NED account.[2] In the event that the transfer of production resources (input use) is treated as "associated costs," a full accounting of associated public investments by State and local governments as well as private investments is required.

The two options outlined above will yield conflicting and faulty results, unless market prices used in the valuation of output are consistent with the cost or supply schedules used in estimating "associated costs."

---

[1] Changes in aggregate output, as well as the extent of locational shifts, are determined in theory by elasticity of demand and the magnitude of the shift in the aggregate supply function.

[2] With this alternative, "associated costs" and project or program costs are treated in the same manner.

Exhibit I.--Analysis of Water Supply Constraints on Economic Activity

Sectors and Water Uses	Units of production 1/	Baseline Condition Water Use		Usable supply	Units of production 1/	Constrained Condition Water Use	
		Per Unit	Total			Per Unit	Total
Manufacturing:							
Food & kindred products							
Textiles							
Chemicals & allied products							
Paper							
Petroleum refining							
Primary metals							
Other manufacturing							
Agriculture:							
Pasture							
Hay							
Feed grains							
Food grains							
Vegetables							
Fruit							
Transportation							
Services							
Households							
Instream uses							
Total							
Deficiency	XX	XX	XX		XX	XX	XX

1/ Measures of economic activity to which water use coefficients are applied to derive total water use. In agriculture acreage would be used in lieu of production or other measure.

Exhibit 2 --Economic Activity Under Alternative Assumptions on Usable Water Supplies (Earnings)

Item	Constrained Conditions (W.O.)	Baseline Condition		With Additional Development	
		Level	Increase	Level	Increase
Basic Industries					
Manufacturing:					
Food & kindred products					
Textiles					
Chemicals & allied products					
Paper					
Petroleum refining					
Primary metals					
Other manufacturing					
Agriculture:					
Pasture					
Hay					
Feed grains					
Food grains					
Vegetables					
Fruit					
Transportation					
Services					
Total employment					
Total population					
Households					
Instream uses					
Total					

Other Applications

In other planning situations, interregional shifts in production may be deemed unlikely or of minor importance. Nonetheless, economic projections play an important role in multiobjective evaluation, as the evaluation process is fundamentally a projective process. The following discussion outlines the use of projections in evaluation.

Flood Control Projects and Programs. The questions to be resolved in the evaluation of flood protection measures are: (1) The extent of industrial, commercial and residential growth in flood prone areas without flood control improvements; (2) acceleration of such future growth with flood control improvements under consideration; (3) the net locational advantages of the accelerated growth in the flood prone areas. These problems of projective measurement are in addition to conventional flood damage evaluation. Projections of growth in flood prone areas constitute a complex problem in which land use patterns play a major role. In making flood plain projections, the OBERS projections may serve only as an indicator of future growth in the overall area in which the flood plain lies. Except for agricultural and a few cases where the supply of suitable land for industrial development is severely limited, the impact on other regions may reasonably be disregarded.

Municipal and Industrial Water Supply Projects. The major variables in the evaluation of the "needs for" and benefits from M & T water supply projects are population, industrial and commercial activity, efficiency of water use coefficients, and the usability of return flows.

The geographic specificity of stream flows and points of withdrawal (existing and potential) is such as to impose rather exacting requirements for geographic detail regarding population and economic activity. The OBERS projections for SMSA's in the series "E" reports will go far toward meeting this need.

Water Based Recreation. Key variables in demand equations for recreational resources and opportunities are population and per capita income. These are provided by the OBERS reports. However, greater geographic detail may be required. Use of streams, water surfaces, and associative facilities are clearly related to their location in relation to resources and facilities and in relation to geographic distribution of population. Benefit estimates are directly related to patterns of recreational use. But they are also related to associated travel time and expenditures. To the extent that increased usage is counterbalanced by reductions in use in competing facilities, estimates of such reduction are accounted for in both the NED and RD accounts as external diseconomies.

The foregoing discussion does not exhaust the use of projections in multi-objective evaluations. Neither does it portray in full the problems and difficulties involved. Comprehensive treatment of the subject matter would cover harbor development, inland navigation, water quality, fish and wildlife, and such special problems as flood plain zoning and land acquisition. And each community and region offers special problems unique unto itself.

The Need for Alternative Projections and Sensitivity Analysis

Some of the uses made of the OBERS projections require the development of alternative or adjusted projections if the planning process is to be fully effective. As indicated earlier, there is a degree of uncertainty in any projection. To compensate for this uncertainty, the planner needs to know how much a change in each projected variable will affect the specification of his plans.

Sensitivity analysis will enable the planner to determine which projected items cause significant changes in his plan and permit him to compensate for them. It may be accomplished by varying the level of the projected data to determine the magnitude of the effect in the projected use. The compensation may take one of two forms. First, it may be possible to devote more time and effort to refining the projected items to which the plan is particularly sensitive and thereby eliminate some of the uncertainty, or secondly, if that is not possible, he may be able to build into his plan a degree of flexibility which will permit it to accomodate different levels of future activity.

In addition to their use in making sensitivity tests, alternative projections are needed if an economic remedial or developmental program is to be instituted. In such cases, a comparison of the new projections with the baseline projections will provide a measure of the effects of the program.

It was indicated earlier in this presentation that the OBERS projections need to be augmented by more small area detail for some uses. There is considerable uncertainty in small area projection. Sensitivity analysis and flexibility in the plan are necessary if the plan is to be based on such small area data.

Summary and Conclusion

This discussion has not given a full account of all the potential uses of the projections or the problems involved in their use in multiobjective planning. However, certain summary statements can be made:

1. As an integrated and consistent set of national and regional economic and demographic information, the OBERS projections provide a unifying framework for multiobjective planning evaluation.
2. By means of other information systems, the projections are converted into future demands for various goods and services associated with water and related land resources. In this process, some augmentation of the OBERS projections may be necessary.
3. A comparison of the projected demand of water related goods and services with the supply of these goods and services indicate whether or not additional supplies need to be developed if the projections are to materialize.
4. The Principles and Standards require that beneficial and adverse effects of a proposed plan be measured by comparing the estimated conditions with the plan, with conditions expected without the plan. Therefore, it is necessary where the projections imply development to determine what the "Without" condition will be.
5. If the "Without" condition differs from the projections, the equivalent of an analysis of regional costs of production is necessary to determine whether or not significant interregional shifts in economic activity are involved. The evaluations required by the M.O.P. accounting system require analytical systems as well as the projections per se. Many of the analytical problems are unresolved.
6. In a majority of cases the projected economic activity with and without the study plan will be the same, thus eliminating the need for the interregional analysis.

7. Because of the uncertainty associated with the projections, sensitivity analysis should be employed to determine when flexibility should be maintained in the plan to accommodate alternative futures.

ENVIRONMENTAL PROJECTIONS AND CARRYING CAPACITY MODELS

A. Bruce Bishop
Associate Professor of Civil & Environmental Engineering
Utah State University

Environmental Projections and the Principles and Standards

The inception of water projects has generally proceeded from a recognition of present problems and projections of future water needs for such uses as municipal and industrial supplies, irrigation of lands to expand agricultural production to meet growing demands for farm products, and development of hydropower potential to meet rising energy demands. Multipurpose plans were then formulated to meet the predicted growth levels in economic activity and population for the area.

However, environmental and quality-of-life concerns have injected an additional set of needs and problems into water resources plan formulation, and have shifted the planning focus from multipurpose to multiobjective considerations. The Principles and Standards recognition of environmental quality objectives as appropriate planning components introduces the need to produce environmental projections, as a parallel to economic projections, as a basis for plan formulation and evaluation. The purpose of this discussion is to examine the role and application of environmental projections in water resources planning as prescribed by the Principles and Standards, to provide overview of ongoing work related to the development of environmental projections, and to present a framework for producing such projections.

The Environmental Quality Objective and Environmental Projections

The complementary role of economic and environmental projections in the water resources planning process is portrayed by the following statement from the Principles and Standards (Water Resources Council, 1973):

> The identification of the specified components of objectives will necessarily involve an appraisal of future economic and environmental conditions expected without the plan as compared with those desired by people for the planning area. In addition, a sufficient inventory and appraisal of the water and land resource base of the planning area will be necessary. (p. 14)

An appraisal of future environmental conditions in the absence of water and land resource plans implicitly requires the making of some kinds of environmental projections. Furthermore, the above statement infers that environmental projections should be responsive to four general areas of concern:

1. Where will we *likely* go from here? What are the probable environmental future(s) under "without" plan conditions?
2. Where do we *desire* to go from here? What are the goals and normative requirements for plans?
3. Where is it *possible* to go from here? What are the environmental futures obtainable through the implementation of water resources plans (the with conditions)?
4. Where do we *expect* to go from here? What is feasible in terms of the most acceptable path given both what is possible and the targets or goals we desire to achieve?

The processes that affect the overall quality of the environment are economic and social for the human environment and evolutionary for the natural (physical and biological) environment. The Principles and Standards recognize that in order to improve the "quality of life" relative to both natural and human environments, the pattern and level of production and consumption activities must be compatible with capabilities of the natural environment, as well as with social preferences. Recognizing that society is a composite of a wide range of values and expectations, clearly conflicts will exist between consumption associated with desired life styles and feelings for the future conditions of the natural environment. To reconcile the attitudes and expectations for the human environment and the quality and stability of the natural environment, the planning process must take cognizance of both economic and environmental projections in order to develop plans that will properly balance the two.

Environmental Projections in the Water Resources Planning Process

In the context of the planning process presented in the Principles and Standards, environmental projections have three important uses. How these fit within the planning process is depicted in Figure 1.

Identification of components of the EQ objective. Environmental projections provide the insight needed for expressions of problems and needs under the environmental quality objective. As the Principles and Standards point out, the desired achievements of specific environmental quality conditions are in essence the "specific components of objectives" (p. 94) and refer to the "type, quantity and quality of desired beneficial effects." For example, components of the EQ objective may be expressed in such terms as miles of scenic river of specified characteristics, acres of ecological areas of specified water quality standards. These examples suggest that components for the EQ objective may be identified by examining projections against the following two criteria:

1. Standards and goals for EQ expressed by federal and state legislative enactment or executive policies as contrasted with present and likely future conditions.
2. Components of objectives for achievement of specific environmental conditions from the standpoint of public preferences.

Resource capabilities and plan formulation for the EQ objective. The formulation of alternative plans is basically a process of balancing the problems and needs expressed as components in the EQ objective with the capability of the resources to meet such demands. The analysis of environmental conditions "without" any planned action will "reveal the extent and magnitude of unsatisfied component needs and indicate the requirement for some specific plan of action to assure their satisfaction." (p. 98) The analysis of resource capabilities against projected problems and desired conditions, then, essentially answers the question of what resources can or cannot be employed by the plan. "To the extent that the water and land resources without any planned action are unable to meet current and projected needs or to the extent that resource management enables the needs to be met more efficiently there is an evident justification for formulating alternative plans." Further, this analysis leads

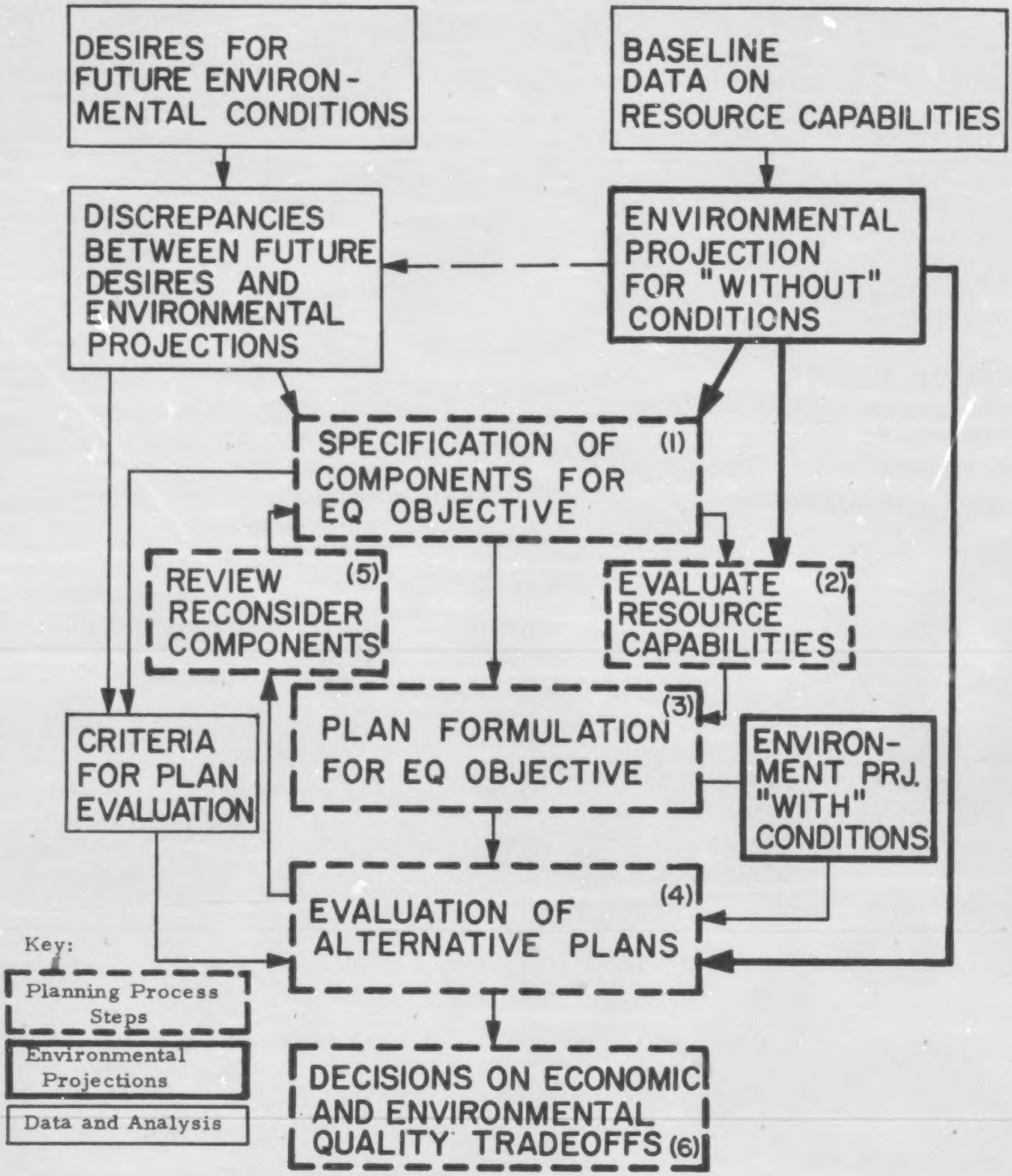

DESIRES FOR FUTURE ENVIRONMENTAL CONDITIONS
BASELINE DATA ON RESOURCE CAPABILITIES
DISCREPANCIES BETWEEN FUTURE DESIRES AND ENVIRONMENTAL PROJECTIONS
ENVIRONMENTAL PROJECTION FOR "WITHOUT" CONDITIONS
SPECIFICATION OF COMPONENTS FOR EQ OBJECTIVE (1)
REVIEW RECONSIDER COMPONENTS (5)
EVALUATE RESOURCE CAPABILITIES (2)
CRITERIA FOR PLAN EVALUATION
PLAN FORMULATION FOR EQ OBJECTIVE (3)
ENVIRONMENT PRJ. "WITH" CONDITIONS
EVALUATION OF ALTERNATIVE PLANS (4)
DECISIONS ON ECONOMIC AND ENVIRONMENTAL QUALITY TRADEOFFS (6)
Key:
Planning Process Steps
Environmental Projections
Data and Analysis

Figure 1. Environmental projections in the water resources planning process.

directly to the determination and specification of elements to be incorporated within the plan itself. Resources for which there exists management and development opportunities are clearly areas for inclusion in plan formulation. These might include, for example, such resources as reservoir storage sites, scenic streams, related land uses, fish and wildlife, and cultural and archaeological areas. "By proper selection of these development possibilities, plans may be formulated to meet the needs for each component of the objectives." (p. 99)

Analysis and evaluation of alternative plans. Environmental projections also carry through the planning process in providing the basis for analysis and evaluation of alternative plans. As noted in the Principles and Standards:

> Existing environmental conditions will be described and presented in terms that best characterize the planning perceptions and ecology of the affected area as conditions would exist without any plan. Similar descriptions will be prepared for the time sequence of the conditions to be expected with and without the plan throughout the period of analysis. The conditions before planning is initiated will provide the data from which to evaluate environmental effects or prediction of change - under alternative proposals including the consequences of failure to adopt a plan for development and use of resources in the area under study. (pp. 60-61)

Examples of areas of environmental effects which must be predicted with respect to alternative plans are changes in natural scenic areas (open space, wild and scenic rivers, lakes, beaches, shores, wilderness areas and estuaries), in unique natural and cultural resources (archaeological, historical, biological, and geological resources and ecological systems), and in quality of water, land and air. The description of possible futures given by projections also enters importantly in the analysis by providing a perspective of the effects of immediate irreversible or irretrievable commitments of resources versus the preservation of future options.

Environmental Projections: Present Work and Future Direction

In dealing with the role of environmental projections in water resources planning, the discussion thus far has not considered the question of whether the needed projections could be produced and made available. In fact, the art and science of environmental projections in contrast to economic projections are still in early stages of development.

Indices for Measurement and Projection of Environmental Conditions

One of the keys to progress in the area of environmental projections is a meaningful system of reporting environmental status and trends. The Council on Environmental Quality (1972) noted in the lead chapter of their 1972 report that "one of the most effective ways to communicate information on environmental trends to policymakers and the general public is with indices." An index is described simply as a quantitative measure which aggregates and summarizes the available data on a particular problem. As such an index has three general characteristics: It is quantitative, it is a summary of relevant data, and it relates to some particular purpose or problem. Hence, it is likely to be a composite of a number of specific indicators of a type of problem, such as BOD , TDS, DO and temperature in water quality.

Whereas socio-economic indices, such as population, economic production (GNP), consumer price index, wholesale price index and unemployment rates provide useful indication of economic trends and a basis for forecasts, environmental indices must likewise be developed to illustrate major trends and point up significant environmental conditions. As the Council on Environmental Quality (1972) pointed out:

> The development of environmental indices has been slow. Many useful environmental data, therefore, lie in bulky volumes or on computer tapes and are used only rarely. The Council, working closely with other Federal agencies, is attempting to develop meaningful indices to remedy this situation.

To remedy this problem Council has undertaken research, jointly funded by the Department of Commerce and the Geological Survey, through a newly formed committee of the National Science Foundation. San Diego County (Bonner, no date) has also been developing a set of environmental indices as part of an integrated regional environmental management program. A sample of those related to water resources planning is shown in Table 1. Some states, such as North Carolina (Paul, 1972), have been pursuing a similar course. Indices for a number of particular areas, such as air

Table 1. Examples of San Diego County Environmental Quality Indices.

Quality Index Categories	Definition of Category	Proposed Quality Indicators	Method of Expressing Quality	Data to Be Collected	Data Source(s)
WILD LIFE AND NATURAL VEGETATION	This includes wildlife & its habitat, which is not part of developed park land category. Ecologically valuable niches are also included in this category even though they may be part of the "open space" indicator in the land use category.	.Acres of wild life habitat .No. & total population of each species of: .Game & non-game animals, birds, fish, lizards, snakes & other creatures .Flora, number of species & abundance of each .Acres of especially valuable habitat--wetland and other .Threatened species of the region	Total acres & ratio of wild life to acres, by species % change Acres, and % of total, and Sites lost Statement of present status	No. of acres & No. of species and population of each Game birds and animals taken during hunting season Status of troubled wild life	Calif. Dept of Fish & Game Calif. Dept of Fish & Game IREM Inventory of Natural Resources IREM Inventory of Natural Resources Calif. Dept of Fish & Game
NATURAL RESOURCE DEPLETION	Rate of use of renewable and non-renewable resources of the region & impact on local economy of the unavailability of imported resources.	.Water table depth .Prime agricultural land .Historical & archaeological sites .Unique land forms .Minerals - principally construction materials .Imported water .Natural Gas .Others to be developed	.No. of months of reserve water in the ground .% of total lost this year to development .No. threatened by development % used this year % for ___ years Supply remaining .% of total requirement that is imported .Impact of substituting liquid fuel for gas	Depth of ground water Acres lost No. of sites vs. number threatened Amount of material used by year for last 10 years .Acre feet of water imported vs. a.f. used .Ratio of liquid to gas fuel used	County Dept. of Agriculture IREM Inventory of Natural Resources Local materials suppliers .Water Depts. .Utility Companies
WATER	1) Fresh Surface Water .Lakes & Reservoirs .Recycled Water 2) Ground Water 3) Lagoons & Days 4) Off-Shore Coastal Waters	.Dissolved Oxygen (DO) .Total Coliform .Nitrate .Phosphate .Temperature .Total Dissolved Solids .Toxic Substances .pH .Turbidity or Transparency.	Acceptable for each intended use--e.g., accepted for: .Drinking or P.W.S. .Shellfish & Swimming .Swimming .Non-Contact Sport .Water Fowl .Agriculture .Navigation	Level of each indicator in each type of water	1) Private water companies Irrigation Dist. & Municipal water depts, Controlling Lakes & Reservoirs 2) State Dept. of Water Resources 3) RWQCB 4) State Dept. of Navigation
LAND USE or LAND USE SHIFT Acres converted to higher intensity use or converted from "open space" status to "developed" status e.g., covered-over land.	Intended to measure rate at which land is being converted from low intensity use; the rate at which "open space" is being used up, intrusions on ecologically sensitive or valuable land, and provide a measure of "urban sprawl"	."Urban green" or open space in urbanized areas .Intrusions into ecologically sensitive areas; e.g. .Wet lands .Flood plains .Agricul. land .Land use shift .Premature development .New strip development .Changes in Housing Density	Total acres and % urbanized area Total size and % of acreage intruded upon: eco-sensitive wet land, flood plain or other No. of acres of % of "open space" used per year No. of acres developed in subregion or traffic zone, not in accord with general plan Along side of arterial roads Dwelling units/acre	Acres added or lost each year Acres intruded upon each year, by land class Acres intruded upon each year, by land class Acres intruded upon each year, by land class Acres intruded upon each year, Changes in intensity of land use	Regional Plng Data Base Regional Planning Data Base County Agri. Dept. Regional Planning Data Base Regional Planning Data Base Regional Planning Data Base
RECREATIONAL RESOURCES (The Mitre Corp., under contract to CEQ, is producing an index of this type that will permit comparison of San Diego with 10 other urban areas.) Regional Planning has established a goal of 15 acres of park land per 1000 pop., which would be factored into the expression of quality.	All developed park land and accessible water area, including lakes, bays, ocean beaches within 50 miles of the population centroid of the region, with a weighting applied to compensate for the distance from the population center to each park. Standards proposed for park land are same as those to be proposed by President's Council for Environmental Quality (CEQ).	Developed park land .Within urban perimeter .Within 25 miles of urban perimeter .Beyond 25 & within 50 miles of urban perimeter Water-based recreation .Accessible lake, bay, or lagoons .Beaches	.Acres per 1000 people in County, unweighted .Acres per 1000 people on basis of proposed weighted values: .Acres/1000 people with wt. of 1 acre=1 .Acres/1000 people with wt. of 1 acre= 2/3 .Acres/1000 people with wt. of 1 acre= 1/3 Acres of surface area: .within 30 min. of pop. centroid = 1 .In rest of county = 1/4 1 mi. beach within 30 min. of pop. centroid = 1 All other = 1/4	Total park acres inside the urban area; within 25 miles of; and within 50 miles of the urban perimeter Total surface area for water-based recreation	U.S. Dept. of Interior, Bureau of Outdoor Recreation Calif. State Dept. of Parks County Park Department Park & Recreation Depts. of the Cities 1970 Census Data, as updated by Regional Plan'g

and water pollution, land use, pesticides, recreation and wildlife, have also been under development. However, these efforts have mainly been oriented toward urban environmental quality and, therefore, may need to be adapted for use in water and land resources planning.

To establish indices for water resources planning projections suggests first that environmental indicators relevant to water resources planning should be identified and indicators constructed which reflect important environmental changes consistent with the levels of planning established in the Principles and Standards. Such indices should meet the following criteria:

1. Indicative of the important dimensions of the EQ objective.
2. Reflect established federal and state environmental standards.
3. Capable of being related to components of plans that will affect or change the level of the indicator.
4. Data can be gathered and analyzed economically and efficiently on a regular basis.

A committee under direction of the Water Resources Council is now working on the problem of measurement of environmental quality effects (Hickman, 1974). This effort should make an important contribution to describing a set of indicators which can be usefully projected in water resources planning.

The projection of changes in regional environmental quality is the product of a descriptive and analytical capability to trace over time measures and indicators of environmental quality. As the diagram in Figure 2 shows, a system of environmental projections is logically linked with socio-economic projection. The diagram indicates the interrelation of economic and environmental change and illustrates four dimensions which are relevant to the capacity of the environment to support or sustain various levels of socio-economic activity and to the overall projection of environmental quality (Bishop, et al., 1974).

1. Resource-production relations: The capacity of available resources to sustain rates of resource use for current and future use and production.

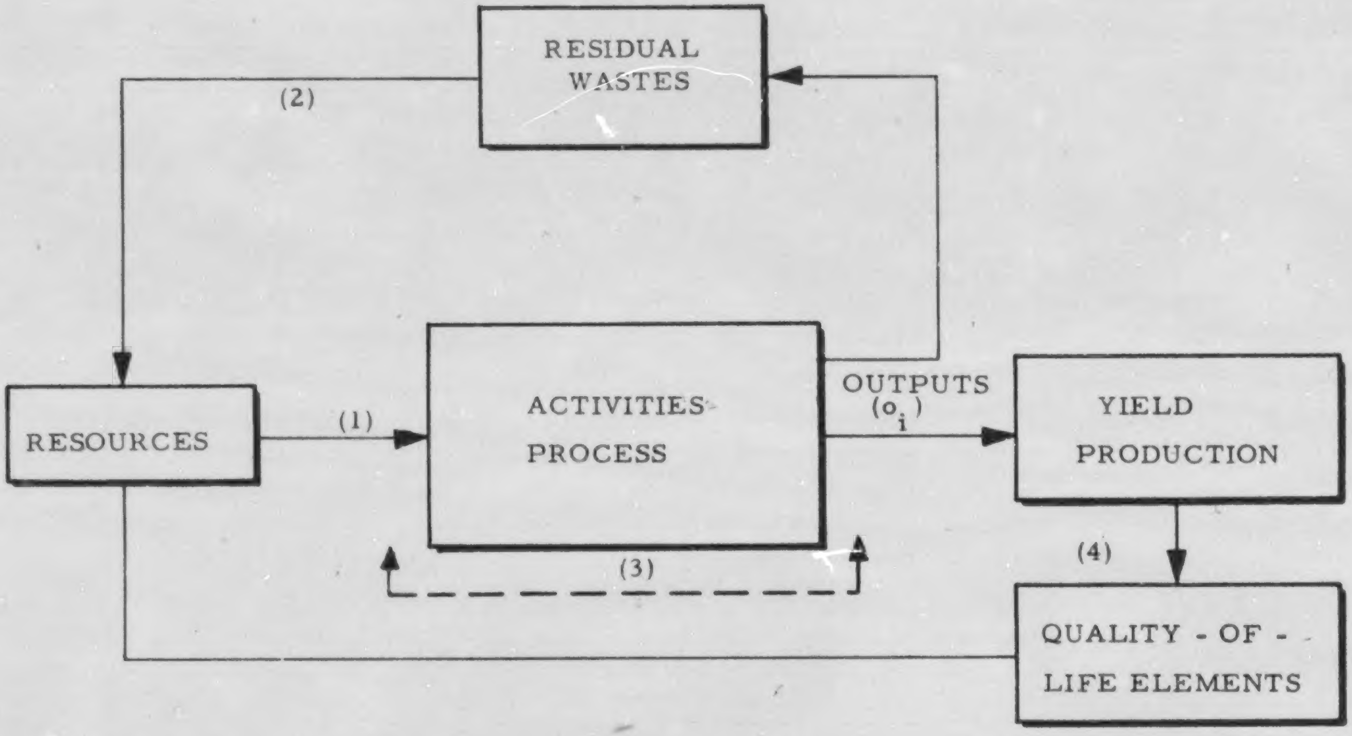


Figure 2. Overview of environmental capacity relations in projecting environmental quality.

2. Resource-residuals relations: The capacity of the environmental media to assimilate wastes and residuals from production and consumption at acceptable quality levels.
3. Infrastructure-congestion relations: The capacity of infrastructure resources (management, distribution, and delivery systems) to handle the flow of goods and services and resources used in production.
4. Production-societal relations: The capacity of both resources and production outputs to provide acceptable quality-of-life levels.

The linking of models for an effective system of projections will certainly require further study and research to establish baseline conditions, monitoring programs to provide a continuing data base, and sets of models, operational rules and procedures to making forecasts of future conditions.

Current Work Related to Environmental Projections

Concern for the current state of the environment's health and the trends and prospects for the future, as expressed in the National Environmental Policy Act, has engendered two types of efforts which attempt to assess potential changes in environmental quality. The first of these is the description of environmental changes or impacts resulting from the implementation of particular actions. These are generally framed in the context of the Environmental Impact Statement required by NEPA. The second aims toward an assessment of environmental quality effects resulting from broader regional changes in social and economic structure associated with varying patterns of man's activities. One of the purposes of the annual report of the Council on Environmental Quality is to address changes in environmental quality of this type. These two areas provide a convenient classification of the manner in which predicting of environmental change has been approached and the various tools and methodologies that are under development.

Project assessments. The requirements of NEPA direct federal agencies to prepare a detailed statement of environmental impacts of actions significantly affecting the quality of the environment. To the extent that the

EIS addresses future changes in EQ it represents a kind of environmental projection for proposed "with project" actions. Efforts to comply with this requirement have generated untold volumes of narrative descriptions as well as the development of a number of techniques are largely of two types, matrices and networks, and both usually rely on expert judgment as the method of analysis.

Matrix approaches (Leopold et al., 1971; Wirth and Associates, 1972; Dee et al., 1972) attempt to provide a framework for systematically exploring the effects of the aspects of proposed actions upon an exhaustive listing of environmental characteristics. Entries in the matrix show whether or not there is an impact, whether it is positive or negative, and the degree of intensity. Qualitative descriptions of significant impacts usually accompany an impact matrix analysis to provide further discussion of the nature of the impact.

Network approaches (Bishop, 1973; Nathan, 1972), rather than fitting the impact analysis within an arbitrary matrix structure, begin with the basic components of proposed actions and derive a cause-effect network which leads to the identification and determination of the environmental impacts as a chain of consequences. The network approaches do achieve an additional level of information through their capability to show feedbacks and interactions among impacts, but as with matrices they also suffer from the lack of a good quantitative base for measuring actual change in environmental quality levels.

Environmental impact assessment, as an investigative process, does provide a limited view of environmental changes associated with components of plans at some points in time in the future. However, because of the nature of the assessment tools and approaches these generally present only a static snapshot picture of conditions at selected points of time in the future. As such, they do not consider the important aspects of the dynamics of change, such as rates of change and the time path of change followed. The matrix approaches generally consider only direct first order impacts of the project components. However, network analyses can be effectively used to identify secondary project effects in socioeconomic sectors and the higher order environmental impacts flowing from plan components and their secondary effects. With both approaches, measurement of the degree of change is still highly problematical and usually relies on professional experience and subjective judgment.

Regional assessments. It can be fairly said that many of the basic goals that have been sought in manipulation of the natural environment have been economically and socially oriented. At the same time changes in the natural environment are going on through the evolutionary processes which are the result of past environmental situations. Thus, the spatial distribution of activities between natural and human environments are "the result of systematic responses to two selection processes (evolutionary versus economic) that are both rewarding efficiency but under different time domains and resource constraints." One of the basic problems, therefore, in quantifying and projecting the magnitude of environmental change is in identifying what proportion is attributable to baseline demands imposed within the natural environment itself and the proportion which results from man's socio-economic activities.

While economic projections have been the key determinants in water resources planning in the past, the interdependence of the factors must be considered in developing environmental projections as related to the density and distribution of populations, industry, agriculture, transportation, utilities and other activities. This view of environmental projection is set forth in the Principles and Standards as follows:

> The components of the objectives will be drawn for both current and future conditions. Projections should be made for selected years over a specified planning period to indicate how changes in population and economic conditions are likely to impact on the components over time. (p. 96)

In this regard, the purposes and techniques of environmental impact assessment clearly do not fit the requirements and needs for a capability to assess short and long term environmental changes, and the associated problems and needs which result from man's social and economic activities. The two major techniques that have been adapted and applied to the development of environmental projections which are integrated with levels of regional, social and economic activity are the methods based on economic input-output models and methods using simulation modeling approaches.

Input-Output (I-O) analysis, essentially an examination of the general equilibrium conditions of production, has been widely used to estimate the total impact on all sectors of an economy arising from a change in final demand for the output from any one or several economic sectors. For applications within the context of environmental projections, I-O analysis can be extended to include the estimation of the residuals associated with any level of production, and more particularly, measurement of the change in residual volumes when output changes (Leontief, 1970).

Given a vector of final demands for each sector's output, Y, and a matrix of technical coefficients, A, where each a_{ij} is the value of input from sector i per dollar of output from sector j, the level of sectoral outputs (denoted by a column vector, X) is given by

$$X = AX + Y$$

Solving for X yields

$$X = (I-A)^{-1} Y$$

in which I is an appropriately dimensioned identity matrix. Thus, a change in any element of Y will result in changes in all elements of X; equivalently, any change in the final demand for one output will result in changes in all outputs.

Now, virtually any production process results not only in outputs but also generates residuals many of which have negative environmental effects (e.g., air and water pollution, noise, etc.). This can be represented by constructing a matrix, R, where each element defines the amount of each type of residual or pollutant (P) discharged per dollar of output (X) produced in each sector. The total level of each pollutant then is given by

$$P = R \cdot X$$

and since $X = (I-A)^{-1}Y$ we can determine residuals as a function of final demand by

$$P = R(I-A)^{-1} Y$$

Thus, not only can any change in final demand be traced through the system to determine its effect on output in all sectors, the model can be used to predict the effect of such a change on the levels of all sorts of residuals associated with that change in production. Clearly this type of analysis assumes that technology is constant, at least during the time period necessary for the system to adjust to a new equilibrium; that it is possible to make empirical estimates in the difficult area of the residuals matrix R; and that the input-output relationships are linear. Input-output type models with residuals-environmental impact components have been conceptualized by Leontief (1970), Russell and Spoffard (1972), Isard (1972), and Miernyk (1973).

Representative of the I-O approaches is the model developed at Resources for the Future (Herzog and Ridker, 1972) based on University of Maryland Interindustry Forecasting Model of Almon. Features of the model particularly relevant to environmental projections (see Figure 3) are forecasts of both natural resource demand and pollution outputs or loadings which can be distributed regionally. These can be coupled with submodels for water and air to yield water and air quality projections. This model is the basis for the Strategic Environmental Assessments System (SEAS) under development by EPA (Greenfield, 1973). The major difficulty in the use of I-O models for environmental projections is the level of spatial resolution. On the one hand, national I-O tables can only be disaggregated to large regions, while on the other, not many good regional I-O tables exist. Thus, the gross pollution loadings and land use changes from an I-O analysis must still be distributed spatially in a region to gain any predictive capability for specific changes in environmental quality.

Simulation modeling is a process of abstracting physical or socio-economic aspects of a particular system to a set of relationships describing processes and functions occurring in the real system. Simulation involves the use of a model to carry out experiments designed to reveal and predict characteristics of the system.

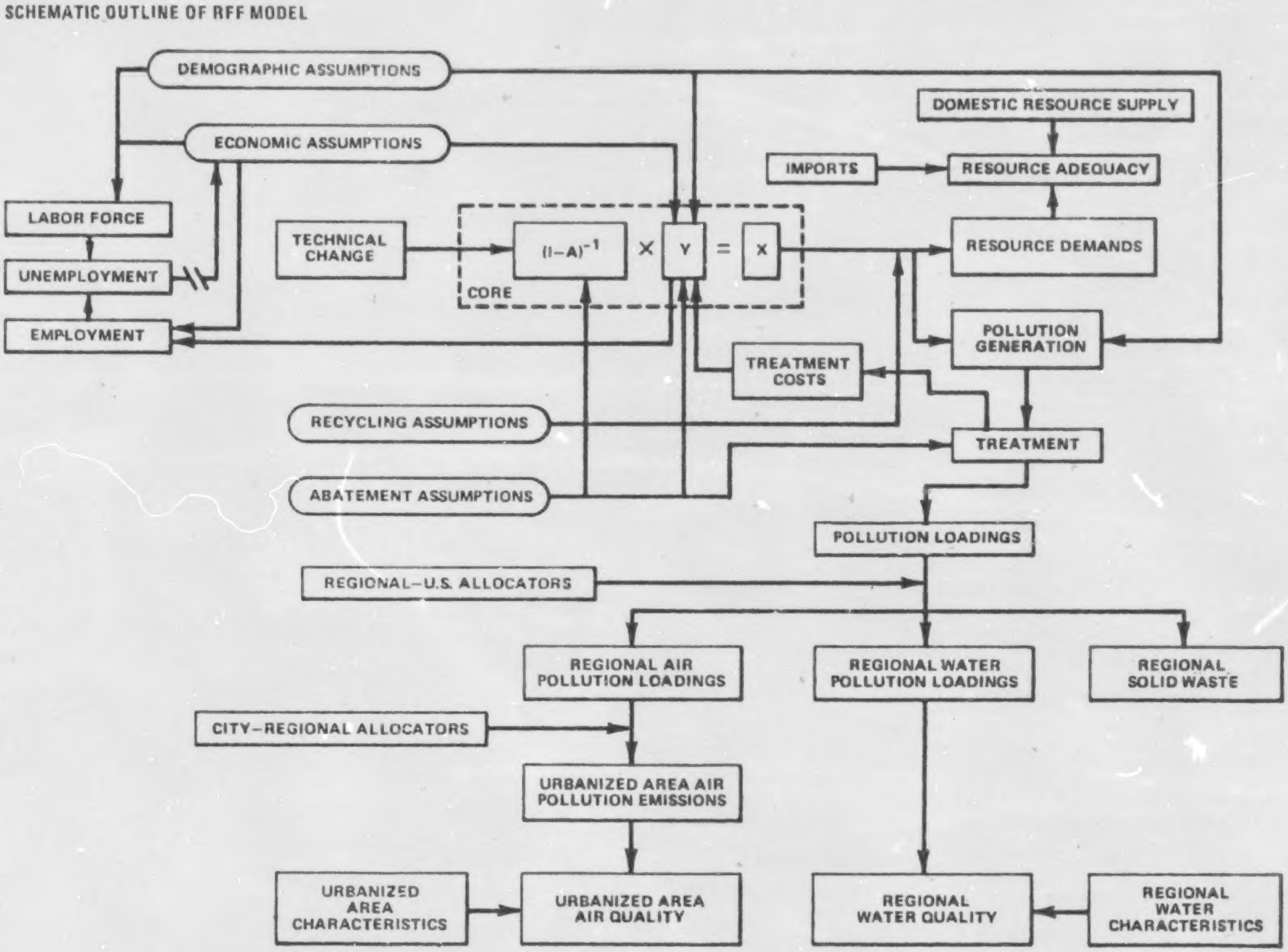


Figure 3. Schematic outline of RFF interindustry forecasting model (Herzog and Ridker, 1972).

The field of simulation modeling, of course, is as broad as the situations of interest to the planner. Consequently, most models are developed for particular problem settings. Of the number of simulation models that might contribute to advancing the area of environmental projections, examples of three approaches or levels of modeling that could assist in making environmental projections are briefly described:

1. Ecosystem modeling--At the highest level of detail is the modeling of particular ecosystems or subsystems as a way of understanding the systems interaction and dynamics over periods of time. Examples of the growing literature in ecological modeling as well as physical biological processes modeling are Van Dyne (1969), Patten (1971), Odum (1971), and Daetz and Pantell (1974). A primary value of such models with respect to environmental change due to natural physical and biological processes which go on in the environment regardless of man's intervention through projects or social and economic activity.
2. Regional simulation model--Regional simulation models are usually built for specific geographical areas (Goldberg et al., 1971; Watt and Wilson, 1973). Generally, the regional model is composed of a number of interacting submodels. One example (Craven et al., 1973) is a regional simulation composed of four basic submodels: Socio-economic, socio-political, land use, and ecological. The flow diagram of Figure 4 shows the interconnection of the various submodels. The model has been developed and operated for the East Tennessee Development District, a 16 county area of 6700 square miles centered around Knoxville. The socio-economic submodel simulates the dynamics of labor supply (including population) and labor demand for the region. The socio-political model simulates the overall impact of the environment on man and the management strategies employed by society in response. The land use model provides the basis for spatially allocating the regional population and the employment forecasts. Finally, the ecological model simulates the burden placed on the ecosystem by spatially distributed land use activities and the resulting impact on the environmental quality

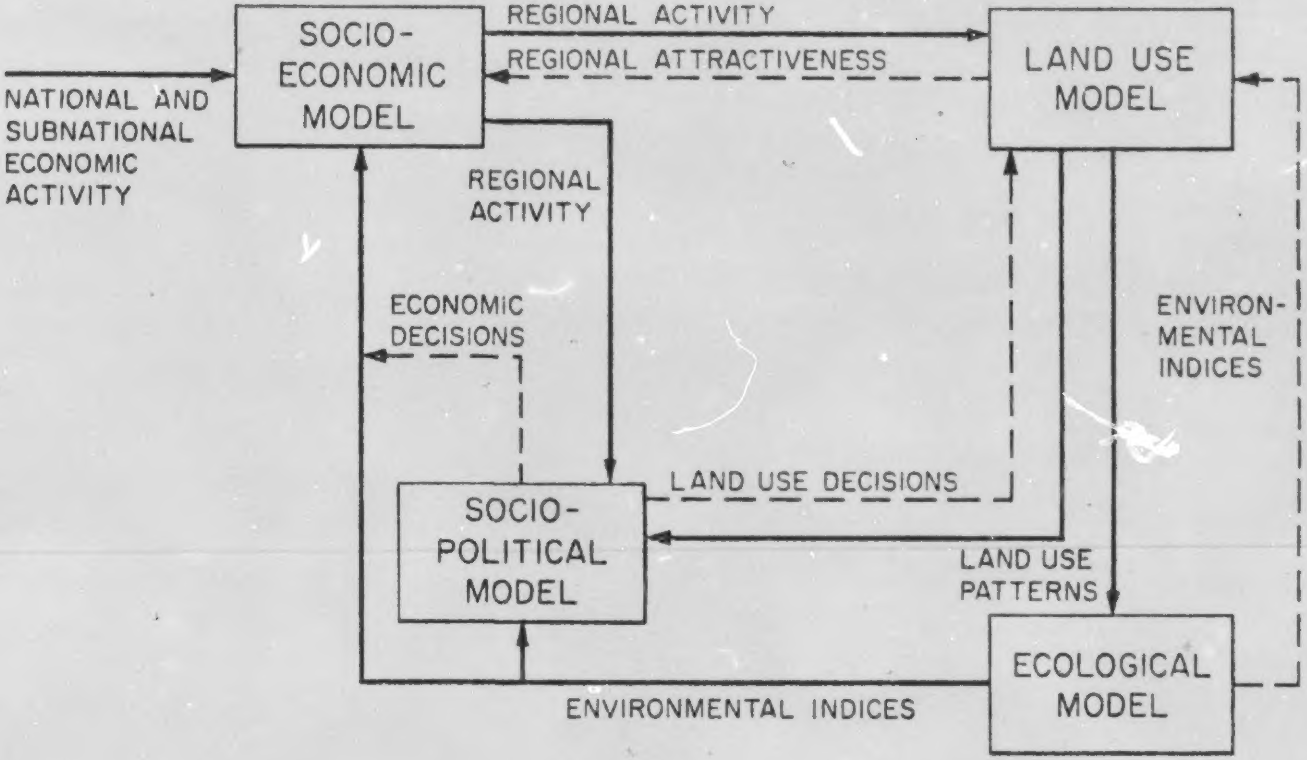


Figure 4. Structure of an example regional environmental simulation model (Craven et al., 1973).

of the system. The ecological model consists of (1) an air and water transport model, (2) aquatic and terrestrial trophic models, and (3) a human activities model. As the brief description of this representative model type suggest, transferability and application to other areas is difficult if not impossible because of many region-specific model characteristics.

3. Cross-impact simulations models--Cross-impact simulations effectively combine the matrix and network impact assessment techniques for depicting interaction and feedbacks among variables with a mathematical formulation for conversion of variable relations into time plots for each variable. One such technique, KSIM (Kand et al., 1973), involves (1) identify the relevant social, economic, and environmental variables, (2) scaling the variables to initial conditions (i.e., conditions estimated to prevail at the time of simulation), (3) developing a cross-impact matrix to describe direct causal relations among the variables, and (4) using KSIM mathematics to convert the interaction matrix into time plots for each variable. Although the technique is applicable to a wide range of settings, the approach is particularly useful for broad overview types of projections where the major objective is to identify relative trends and gain greater insight into interrelations among various factors influencing environmental change. To illustrate how the technique can be used to explore broad future problems of a river basin, the relationships of a few very gross driving forces, environmental constraints, and regional outputs were examined in a simple simulation for the Colorado River Basin (Crawford, and Bishop, 1974).

A cross-impact matrix (see Figure 5) was developed to characterize the interactions that would likely occur under the trends of present policy orientations for eight selected variables. Then, a modified KSIM simulation technique was used to generate a 30-year time plot for the eight variables (see Figure 6). Similar simulations were done for other policy orientations, such as all out energy development or environmental

	A	B	C	D	E	F	G	H
A. Urbanization	1[a]	2.5	1.5	1.5	-2.5	-1.5	1.5	1.5
B. 4-Corners Coal Develop	1.5	0	-.5	-1.5	-2.5	-1.5	2	2
C. Oil Shale Development	1.5	0	0	-1.5	-2.5	-1.5	2	2.5
D. Recreation Level	.5	.5	.5	0	-1	-1	-.5	1.5
E. EQ Level	-1	-2	-2	1.5	.5	.5	-.5	-1
F. Agriculture Production	-.5	-1.5	-1.5	0	-1.5	.5	2	1
G. Water Development	1.5	2	2	1	-2.5	1.5	0	2.5
H. Gross Regional Product	1.5	1	1	1.5	-1.5	1	1.5	.5
Initial Conditions (Normalized 0 to 1)	.4	.2	.05	.5	.8	.1	.5	.5

[a] Level of impact denoted by a 7-point +3 to -3 scale.

Figure 5. Cross-impact matrix for "Trend" future in the Colorado River Basin.

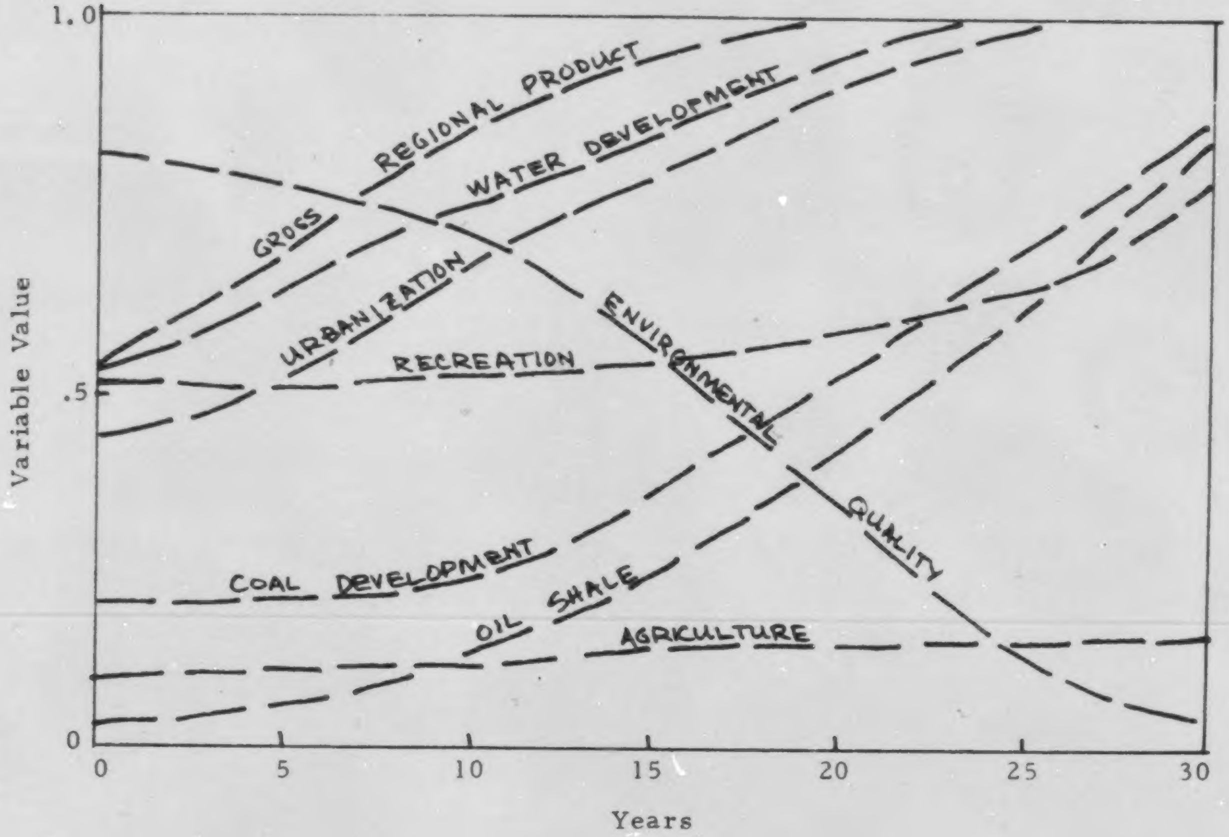


Figure 6. Trend future projections of eight variables for the Colorado River Basin.

preservation. These alternative policy orientations, based on rough estimates of initial conditions and variable interactions, can be used to simulate and provide a general basis for discussion of future environmental considerations. Used in this vein, these alternative futures pose the question, What will happen if ...? The simulation projections are exemplary of the types of problems and areas of potential environmental quality effects, and hence point out some of the issues that would be involved in no action or various planned actions.

A Framework for Environmental Projections

Considering both the application of environmental projections within the water planning process and the necessary integration with socioeconomic projections, an overall conceptual framework for developing and using environmental projections is depicted in Figure 7. As the figure suggests, environmental projection is itself a process for logically examining interrelated changes in human and natural environmental conditions. The following briefly describes the major elements of the diagram.

Exogenous regional forces--The use of alternative future descriptions of regional driving forces in developing projections follows naturally from the recognition that many causes of environmental change are exogenous to the region. These forces cannot be explicitly controlled within the region, yet an understanding of them and their effects internal to the region are of vital importance to predicting environmental changes.

Environmental projection system--The actual predicting of future environmental conditions requires a system for converting natural and human resource inputs, acted on by exogenous and endogenous regional forces, into projected changes in environmental indicators. A comprehensive picture of the analytical relationships and levels of resolution in projecting environmental changes is presented in Figure 8. The diagram recognizes four primary levels of analysis representing progressively higher degrees of resolution. Beginning at a broad regional level, economic and demographic analyses describe production, consumption, and resource exchange within the region in terms of required natural resource, raw material, and social infrastructure inputs, on the one hand, and the outputs of goods and services and residuals, in the other. These four

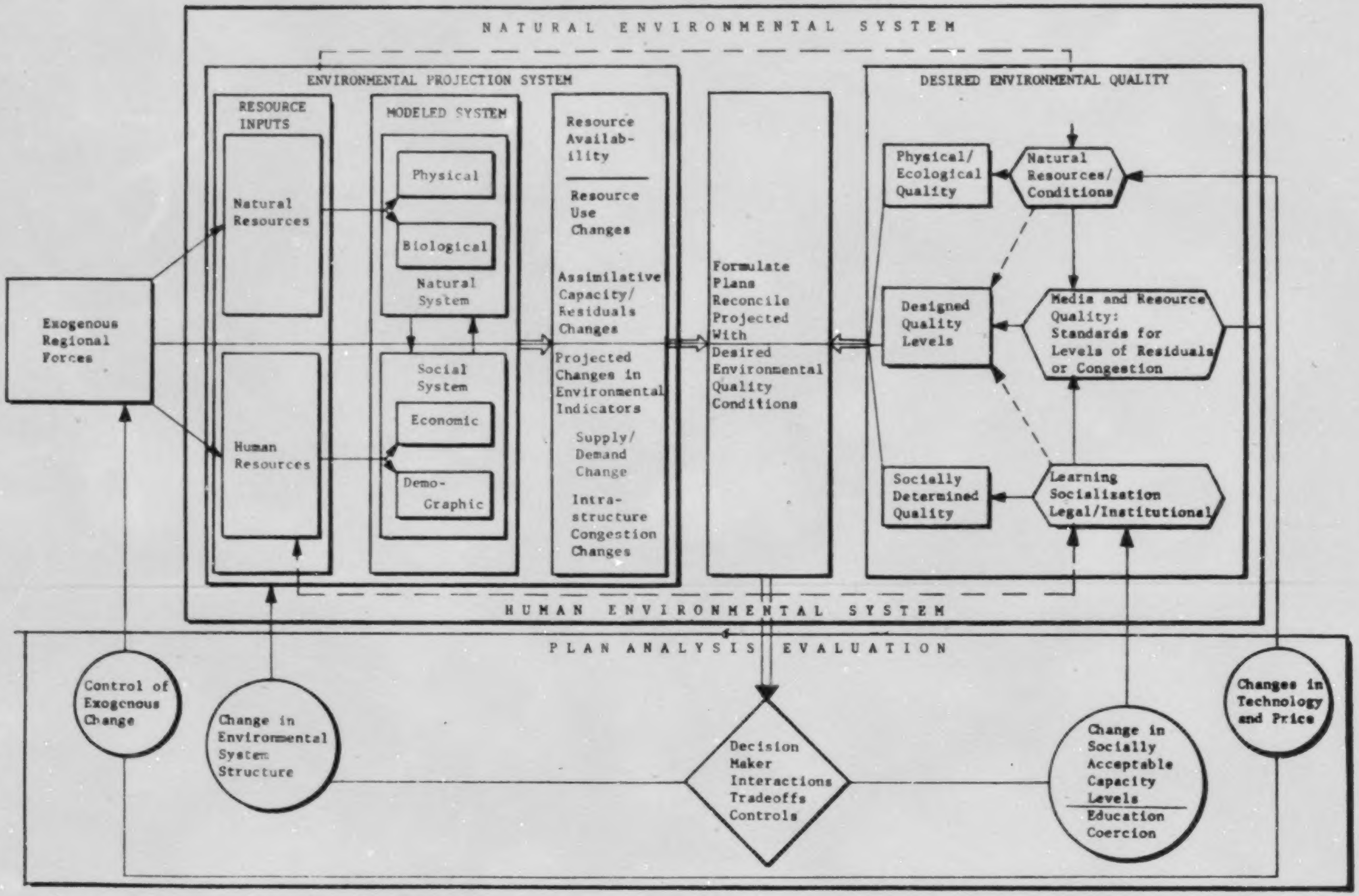

NATURAL ENVIRONMENTAL SYSTEM
ENVIRONMENTAL PROJECTION SYSTEM
RESOURCE INPUTS
Natural Resources
Human Resources
MODELED SYSTEM
Physical
Biological
Natural System
Social System
Economic
Demo-Graphic
Resource Availability
Resource Use Changes
Assimilative Capacity/ Residuals Changes
Projected Changes in Environmental Indicators
Supply/ Demand Change
Intra-structure Congestion Changes
Formulate Plans Reconcile Projected With Desired Environmental Quality Conditions
DESIRED ENVIRONMENTAL QUALITY
Physical/ Ecological Quality
Natural Resources/ Conditions
Designed Quality Levels
Media and Resource Quality: Standards for Levels of Residuals or Congestion
Socially Determined Quality
Learning Socialization Legal/Institutional
Exogenous Regional Forces
HUMAN ENVIRONMENTAL SYSTEM
PLAN ANALYSIS EVALUATION
Control of Exogenous Change
Change in Environmental System Structure
Decision Maker Interactions Tradeoffs Controls
Change in Socially Acceptable Capacity Levels
Education Coercion
Changes in Technology and Price

Figure 7. A conceptual framework for environmental projections in the water resources planning process.

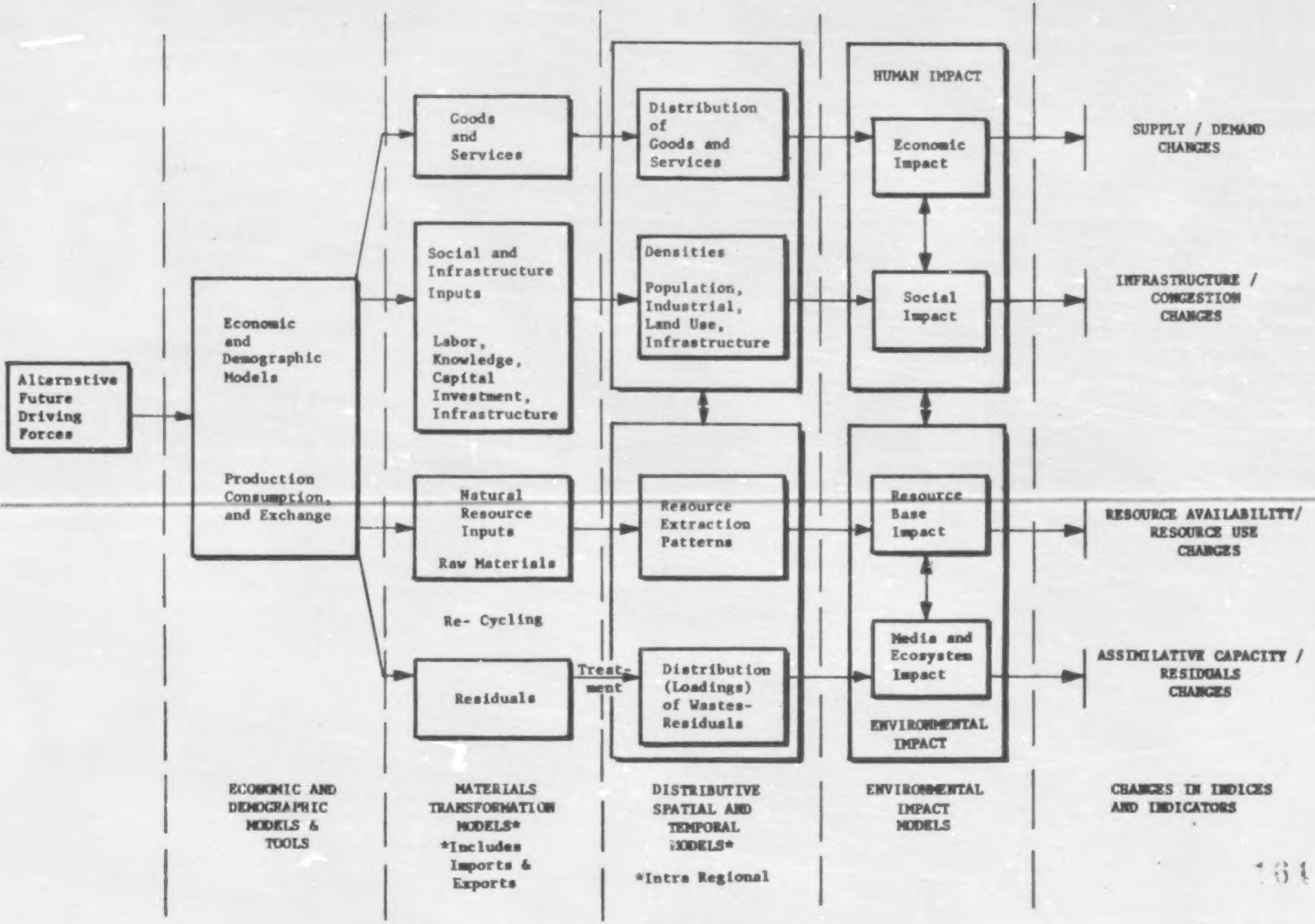

Alternative Future Driving Forces
Economic and Demographic Models
Production Consumption, and Exchange
Goods and Services
Social and Infrastructure Inputs
Labor, Knowledge, Capital Investment, Infrastructure
Natural Resource Inputs
Raw Materials
Re- Cycling
Residuals
Treat- ment
Distribution of Goods and Services
Densities
Population, Industrial, Land Use, Infrastructure
Resource Extraction Patterns
Distribution (Loadings) of Wastes-Residuals
HUMAN IMPACT
Economic Impact
Social Impact
Resource Base Impact
Media and Ecosystem Impact
ENVIRONMENTAL IMPACT
SUPPLY / DEMAND CHANGES
INFRASTRUCTURE / CONGESTION CHANGES
RESOURCE AVAILABILITY/ RESOURCE USE CHANGES
ASSIMILATIVE CAPACITY / RESIDUALS CHANGES
ECONOMIC AND DEMOGRAPHIC MODELS & TOOLS
MATERIALS TRANSFORMATION MODELS*
*Includes Imports & Exports
DISTRIBUTIVE SPATIAL AND TEMPORAL MODELS*
*Intra Regional
ENVIRONMENTAL IMPACT MODELS
CHANGES IN INDICES AND INDICATORS

Figure 8. Analytical relations in projecting environmental change.

classes of resource state changes, associated respectively with resource base, social system, economic system, and environmental media and ecological system, must then be examined at higher degrees of spatial and temporal resolution, including analyses of materials transformation, spatial and temporal distribution of residuals, and finally, changes in human and natural environmental quality levels.

Desired environmental quality--The essential distinguishing feature concerning the information content of projections is that they depict likely changes and, therefore, are analytic and descriptive in nature. In contrast, the desired conditions of the natural environment provide a normative contrast to projections. These are expressed as problems and needs of various public bodies and interests in terms of levels of desired improvements in environmental quality.

Plan formulation--The two sets of projections, descriptive and normative, together provide operational objectives for the formulation of plans. Thus, the tests of usefulness for environmental projections are found in their capability to (1) articulate differentials (shortfalls, excesses, trade-offs) between "desired" (normative) and "realized" or descriptive (empirically determined) changes in environmental quality, and to (2) identify intervention points for achieving improved environmental quality in formulating plans.

Plan analysis and evaluation--Obviously, the analysis and evaluation of plans focus on the divergence as between "real" and "desired" EQ, and is basic to the selection of appropriate and effective plans. "Desired" levels of supply/demand satisfaction must necessarily be weighed against "realized" changes in components of environmental objectives. Likewise, indices reflecting achievement of important features of environmental quality must be arrayed against "realized" indices of economic and social well-being.

Summary

In developing water resources plans, planners and decision makers must continually assess and project the social and environmental implications of present trends and alternative proposals. Approaches to projections of regional activity and effects on environmental systems are developing, but much work is yet to be done in finding workable approaches in predicting the natural and human viability of proposals. Future efforts in the area should be directed toward augmenting planning processes with sound projection procedures that can be used to examine the character of environmental changes that will occur under different levels of social and economic activity, how changes in the physical environment relate to the social objectives and values for resource development and use, and how well various planning proposals achieve desired levels of environmental change.

References

Bishop, A.B. 1973. "Systems Analysis." In Environmental Design and Public Projects. D.W. Hendricks, E.C. Vlachos, L.S. Tucker, and J.C. Kellogg (eds.). Colorado State University, Fort Collins, Colorado.

Bishop, A.B., H.H. Fullerton, A.B. Crawford, M.D. Chambers, and M. McKee. 1974. "Carrying Capacity in Regional Environmental Management." Office of Research and Development, Environmental Protection Agency, Washington, D.C.

Bonner, P.A. no data. "Summary--Environmental Quality Indicators Project." County of San Diego, Integrated Regional Environmental Management (IREM) Technical Report, 1600 Pacific Highway, San Diego, California 92101.

Council on Environmental Quality. 1972. Third Annual Report. U.S. Government Printing Office, Washington, D.C.

Craven, C.W., Jr., F.P. Baxter, C.R. Meyers, Jr., R.J. Olsen, C.R. Schuller, and A.H. Voellzer. 1973. "Regional Environmental Systems Analysis." ORNL-NSF Environmental Program, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Crawford, A.B., and A.B. Bishop. 1974. "Carrying Capacity and Planning in the Colorado River Basin." In Values and Choices in the Development of an Arid Land River Basin (Colorado River Basin). D.F. Peterson and A.B. Crawford (eds). The University of Arizona Press. Forthcoming.

Daetz, Douglas, and Richard H. Pantell. 1974. Environmental Modeling: Analysis and Management. Dowden, Hutchinson and Ross, Inc., Stroudsburg, Pennsylvania.

Dee, Norbert, J.K. Baker, N.L. Brobney, K.M. Duke, and D.C. Fahringer. 1972. Final Report on Environmental Evaluation System for Water Resources Planning. Battelle-Columbus Laboratories.

Goldberg, M.A., C.S. Holling, and R.F. Kelly. 1971. Vancouver Regional Simulation Study 1970-71. Resource Science Center, The University of British Columbia, Vancouver 8, Canada.

Greenfield, S.M. 1973. "The Strategic Environmental Assessment System (SEAS): A Research Project." Final Conference Report of the National Conference on Managing the Environment. Washington Environmental Research Center, Environmental Protection Agency, Washington, D.C.

Herzog, H.W., Jr., and R.G. Ridker. 1972. "The Model." In Population, Resources, and the Environment. R.G. Ridker (ed.). U.S. Commission on Population Growth and the American Future Report Vol. III, Government Printing Office, Washington, D.C.

Hickman, Gary D. 1974. "Measurement of Environmental Quality Effects." Training Course in the Application of Principles and Standards of the Water Resources Council, Colorado State University, Fort Collins. August.

Isard, Walter. 1972. "Ecologic-Economic Analysis for Regional Development." The Free Press, New York.

Kane, Julius, I. Vertinsky, and W. Thomson. 1973. "A Methodology for Interactive Resource Policy Simulation." Water Resources Research, Vol. 9, No. 1. January.

Leontief, Wassily. 1970. "Environmental Repercussions and the Economic Structure: An Input-Output Approach." Review of Economics and Statistics 52:262-271. August.

Leopold, Luna B., F.E. Clark, B.B. Hanshaw, and J.R. Balsley. 1971. "A Procedure for Evaluating Environmental Impact." U.S. Geological Survey, Circular 645.

Miernyk, William H. 1973. "A Regional Input-Output Pollution Abatement Model." IEEE Transactions on Systems, Man, and Cybernetics, Vol. SMC 3, No. 6. November.

Nathan, Robert R., Associates. 1972. U.S. Deepwater Port Study, Vol. IV: "The Environmental and Ecological Aspects of Deepwater Ports." U.S. Army Engineer Institute for Water Resources, IWR Report 72-8, Fort Belvoir, Virginia.

Odum, Eugene P. 1971. Fundamentals of Ecology. 3rd Edition. Saunders, Philadelphia.

Patten, B.C. (ed.). 1971. Systems Analysis and Simulation in Ecology, Volume I and II. Academic Press, New York.

Paul, Roy A. 1972. Planning for Environmental Quality, Phase I Progress Report. State Planning Division, Department of Administration, 116 West Jones Street, Raleigh, North Carolina 27603.

Russell, C.S., and W.O. Spoffard, Jr. 1972. "A Quantitative Framework for Residuals Management." In Environmental Quality Analysis. A.V. Kneese and B.T. Bower (eds.). The Johns Hopkins Press, Baltimore, Maryland.

Van Dyne, G.M. (ed.). 1969. The Ecosystem Concept in Natural Resource Management. Academic Press, New York.

Water Resources Council. 1973. "Principles and Standards for Planning Water and Related Land Resources." Federal Register, Vol. 38, No. 174, Part III. September 10.

Watt, K.E.F., and J.L. Wilson. 1973. "Regional Modeling Studies by the Environmental Systems Group." Paper presented at Conference on Regional Environmental Management, San Diego County Integrated Regional Environmental Management (IREM) Project, San Diego, California.

Wirth, T.J. and Associates. 1972. "Report and Draft Environmental Impact Statement for the Lake Tahoe Plan and Effectuating Ordinances." South Lake Tahoe, California: Tahoe Regional Planning Commission.

MEASUREMENT OF NATIONAL ECONOMIC DEVELOPMENT EFFECTS

Robert A. Young
Department of Economics, Colorado State University

The purpose of this paper is to outline general methods for measuring beneficial and adverse effects on the NED objective. This discussion will follow the outline established in the earlier session, in that we examine both beneficial and adverse effects, and within these categories, direct effects and external effects are treated

It should be made clear at the out[illegible]t in the hour or so permitted for this discussion, only a few topics [illegible] discussed. For each of the several different project purposes (water supply, flood control, recreation, transportation, electric power, etc.) specific techniques have been developed. In view of the constraint on time, I have been forced to continue the discussion at the conceptual level, rather than delve very deeply into details relating to specific program purposes. A list of references is appended for the convenience of those interested in further refinements and in alternative approaches for specific issues.

Review of Concepts

The previous paper (No. 3) presented a brief summary of the conceptual basis underlying the NED account. The main point of that discussion was the assertion that the concept of "willingness-to-pay" (WTP) provides a measure by which beneficial and adverse impacts related to any program purpose can be expressed in a commensurable basis in monetary units. Thus, a program will provide a net contribution to national economic development if the present value of the willingness of program beneficiaries to pay for program outputs exceeds the present value of willingness of these or other consumers to pay for the resources used in the program in alternative employments. Willingness-to-pay is represented by the familiar downward sloping demand curve which relates money value to quantity consumed (See discussion of Figure 1 in text of Paper 3 for more details).

Measurement of Beneficial Effects: General Approaches

A. Introduction

Reliable forecasts of the actual demand (willingness-to-pay) function for program output are, in practice, rather difficult to derive. This problem can arise for a number of reasons. First, in the case of outputs which are final consumer goods, markets may not exist to price the outputs, and hence, no true willingness-to-pay measure is feasible from observation of actual market transactions. Recreational enhancement is a case in point. Second, it is sometimes argued that due to imperfect competition in the relevant industries, observed market prices fail to represent true willingness-to-pay. Electric power and water supply for community and residential uses may fall into this category. Third, the program output may be an intermediate good, used in producing a number of other commodities for eventual consumer use. In such cases (exemplified by agricultural water supply, agricultural flood damage alleviation and transportation) the task of developing an accurate derived demand schedule relative to each of the (potentially) numerous final consumption goods or services is exceedingly complex, time consuming and expensive.

The implication of the foregoing is that the task of measuring direct NED benefits is one of applying analytical techniques which are more or less suitable approximations to the desired theoretical concept. A number of alternative techniques may be used, including (a) actual or simulated market prices, (b) change in net income, and (c) cost of the most likely alternative. In the following sections, these approaches are considered in turn.

B. Approximating WTP with Actual or Simulated Market Prices

1. Cases where appropriate market prices are observable. If relevant, undistorted market prices are observable, and if the additional output of a plan is not expected to have a significant impact on price, the actual market price will closely approximate the total value of the output. This follows because there will be no consumer's surplus.

If the additional output is expected to have some predictable impact on price (as represented in Figure 2 in the text for Session 3), a price midway between that expected with as compared to without the plan may be used to value the projected increment in output. This procedure would approximate in most cases, the willingness-to-pay, including consumer surplus.

2. Imputing value from observation of related resource markets. A few scattered instances are found in the literature which involve valuing program outputs by measuring increases in the price of related resources, usually land. This approach has been applied, with reasonable success, to agricultural water supply, recreation and water quality enhancement. The technique, however, appears to have limited usefulness in planning activities, since it rests on ex post observation of land price changes over a several year period. While valid as a method of verifying alternative approaches in specific localities, there is little basis for assuming such measures can be appropriately extrapolated to other situations.

3. Simulated prices; the case of recreation. Recreational activities have experienced rising demand in recent years, in response to growing incomes and increased leisure time. Water-oriented recreation is accommodated by development of federal multipurpose water programs, as provided for in the Federal Water Projects Recreation Act of 1965.

For the most part, no market mechanism operates to allocate and value water-based outdoor recreational services. Under such conditions, the increase in recreation services may be measured by various methods of simulated willingness-to-pay.

One approach, commonly termed the "travel-cost" technique, is based on the assumption that observed expenditure behavior can be used as a proxy for prices. The method is an indirect one, in that it imputes the consumption reactions of consumers to hypothetical recreation prices by examining actual spending behavior. Marginal travel costs (i.e., variable costs of automobile operation and incremental expenditures on food and lodging) are taken as measures of how price affects use. If a fee were charged, per capita use rates would be reduced. Applying a range of entrance fees, site demand curves can be constructed for alternative fee levels. Annual values are computed by determining the area under the imputed demand curve.

Another approach, which is receiving more attention in recent years, is by direct interview techniques. The essence of the technique is, through a carefully constructed questionnaire, to elicit from recreationists the maximum price they would pay to avoid being deprived of the use of a particular site. Some question the reliability of responses to hypothetical questions of this nature, although the results of the approach have been found to be similar to findings in the travel-cost framework. See Knetsch, Selected References, Item 7 for detailed discussion.

In view of the relative immaturity of recreation evaluation methodology, the Principles and Standards provides a set of monetary unit values, (p. 52) which can be used in plan preparation.

C. Intermediate Goods and the Change in Net Income Measure

Intermediate goods are those which are used by a producer to yield other goods or services. Water-related plans and programs most often supply water to production processes rather than to final consumers. Hence, the special problems of intermediate good evaluation must be confronted.

Production economic theory tells us that the willingness- of a producer to pay for additional units of a resource is given by the Marginal Value Product relationship. This relation has the same properties as the consumer's demand curve, in that the curve relating price to quantity slopes downward to the right. However, it is often difficult in practice to specify MVP curves, particularly in the case where firms produce a number of products.

The measurement of technique of choice in many cases is the "change in net income", which is, in turn, a special case of a more general approach often called "residual imputation".

Resource valuation is essentially a problem of assigning a "price" to resources or commodities in the absence of market to perform the function. The valuation process called "residual imputation" is a procedure which achieves this by allocating the total value of output to each of the resources used in a single productive process. If appropriate prices can be assigned to all inputs but one, then the remainder of the total value of product is imputed to the remaining resource.

The technique is based upon two major postulates: (1) the market prices of all resources, except the one to be valued, are equal to the returns to the margin (value of the marginal product) afforded by those resources, and (2) the total value of output can be divided into shares such that each resource is paid according to its marginal productivity, then the total value of output is completely exhausted. Consider a simple example where three factors, capital, labor and water are used in the production of a single output Q. We assume that our problem is one of imputing a value to the water resource. By the postulates (1) and (2) we may write:

$$TVP_Q = VMP_L \cdot L + VMP_K \cdot K + VMP_W \cdot W$$

where TVP_Q is the total value of output Q, VMP_i represents the value marginal product of any resource i, and L, K, and W refer respectively to quantities of labor, capital, and water employed. If the value marginal products of labor and capital have been accurately determined, then the value of water at the margin may be computed as follows:

$$TVP_Q - VMP_L \cdot L - VMP_K \cdot L = VMP_W \cdot W$$

or according to postulate (1) we may write:

$$TVP_Q - P_L \cdot L - P_K \cdot K = VMP_W \cdot W$$

The assumptions underlying residual imputation as formulated above are that no residual remains and further that the exact return to each resource can be imputed. The question which arises is whether or not factor payments according to marginal productivities will just exhaust total product. The answer is provided by a principle known as Euler's Theorem which states that, under certain conditions, resources paid according to marginal productivity will result in complete exhaustion of total product. This theorem played a major role in the marginal productivity concept of factor income distribution. The postulates cited previously were shown to be satisfied by production functions homogeneous of the first degree. The Cobb-Douglas type function is one which satisfied Euler's Theorem and has been used in empirical estimation of marginal value products. This function, of the form

$$y = Bx_1^a \; x_2^{1-a}$$

is a homogeneous of degree one. If x_1 is water and x_2 is capital, the respective marginal products may be determined as follows:

$$MP_{x_1} = f_1 = a(Bx_1^{a-1} \; x_2^{1-a})$$

$$MP_{x_2} = f_2 = 1-a(Bx_1^a \; x_2^{-a})$$

This function satisfies

$$y = x_1 \ (aBx_1^{a-1} \ x_2^{1-a}) + X_2 \ [(1-a)Bx_1^{a} \ x_2^{-a}]$$

$$= aBx_1^{a} \ x_2^{1-a} + (1-a)Bx_1^{a} \ x_2^{1-a}$$

or $y = ay + (1-a)y$

Thus, if each resource is paid according to its marginal product, total output distributed between water and capital in the proportions a and 1-a will exhaust total product.

While residual imputation appears to be a very simple technique for estimating shadow prices or resource values it is subject to limitations which should be recognized by the user. These limitations may be conveniently discussed in four broad categories. First, factor payments in accordance with marginal productivity will just exhaust total product only if resources are used to a point at which marginal and average productivity are equal. Resource use at a level less than that necessary for the equality to hold will result in factor payments greater than total product. Resource use at a level greater than is necessary to produce the equality will result in an excess of total value of output over total factor payments. Thus, it is only at a very specific level of resource use, i.e., at a point exhibiting constant returns to scale, that the conditions of residual imputation are met. Thus, the method is valid so long as the requirement of the competitive model (including the equilibrium condition that marginal equals average product) are met.

Second, there is the very serious operational difficulty encountered through the use of prices as indicators of value marginal products for all resources but one. If resources are not allocated so that all factor inputs are employed to the level where prices are equated with value marginal products, the imputational process may result in either under or over estimation of the value of the resource in question.

Third, even though the production function exhibits homogeneity of degree one and prices of all other resources reflect value marginal product, there may be resources which have been inadvertently omitted from analysis. A case in point would be the omission of the management function and the associate risk bearing responsibility. If these factors are not accounted for in the analysis, returns properly attributable to management and risk bearing are imputed to the residual resource and the resultant estimate of value is overstated. Finally, there is a more general problem which arises when resources other than water are not directly priced in markets. Errors in assigning opportunity cost values to such resources would lead to errors in value imputed to water.

The "change in net income" measure, in effect, applies the principles developed above, and values beneficial effects in terms of the difference between net income of program beneficiaries with as compared to without the program. In symbols, the measure can be expressed along the following lines. Visualize a multi-resource, multiproduct production function.

$$f(Y_1, Y_2 \ldots . Y_m; X_1, X_2 \ldots . X_n) = 0$$

where

Y_i $(i = 1, 2 \ldots . m)$ are products

Y_j $(j = 1,2 \ldots . n)$ are productive resources (including water)

Net income is defined as

$$Z = \sum_{i=1}^{m} (Y_i P_{y_i} - \sum_{i=1}^{n} x_j P_{x_j})$$

where

Z : net income

P_{y_i} : price of i^{th} product (assumed constant)

P_{x_i} : price of j^{th} resource (assumed constant)

X,Y as previously defined

Letting subscripts 0 and I respectively, refer to magnitudes without and with the project, change in net income is given by

$$\Delta Z = Z_1 - Z_0 = \sum_i (Y_{i1} P_{y_1} - \Sigma x_{j1} P_{x_j}) - \Sigma (Y_{io} P_{y_i} - \Sigma x_{jo} P_{x_j})$$

When beneficial effects must be imputed by the change in net income process for a number of different production processes, the budgeting process can become analytically quite tedious. In such cases, mathematical programming techniques can be used on a digital computer to facilitate the process.

The possibilities for error with this technique increase as the economic importance or the role of water in the overall process diminishes. Agricultural processes are more suitable than industrial or manufacturing uses. Hence, the change in net income finds its principle application in evaluating agricultural water supply and agricultural flood damage alleviation.

D. The "Cost of Most Likely Alternative" Method

When other approximations to the total willingness-to-pay are not feasible, the "cost of the most likely alternative" may serve as a measure. (This technique is often referred to as the "alternative cost" approach, for brevity). The essence of the procedure is that measured beneficial effects of a program are limited to the cost of a likely alternative procedure, process or means for achieving the same end.

In a general sense, the alternative cost procedure is a conceptually appropriate approximation of willingness-to-pay. This follows because a rational decisionmaker should not be willing to pay more than the cost of the least expensive source of a good or service.

The approach may appear to be deceptively simple, but there are a number of possible cases, including private alternatives to public projects, public alternatives to each component of dual purpose projects, etc. All of the complications have interesting features. However, our purpose is not to review the possible complications but rather to summarize the general character of the technique.

Consider first the situation in which a private alternative to a public development exists (say by railroad system for transporting commerce as an alternative to a navigation development). Assume that the two alternatives provide the same commodity or service in like amounts. In Figure 1, output Level E is the amount which would be provided by either alternative.

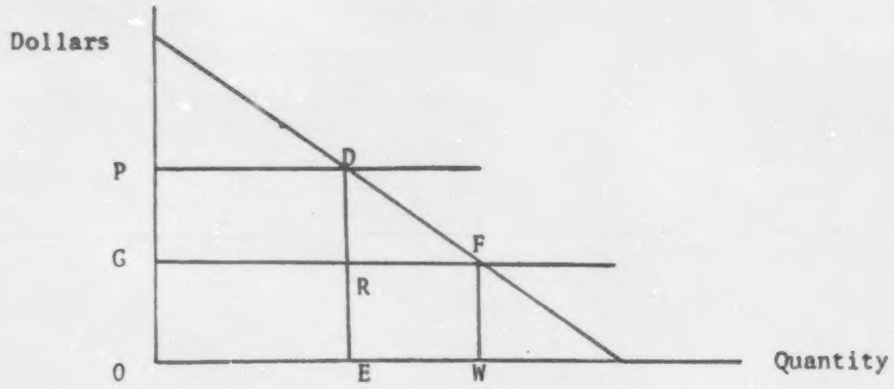


Figure 1. Alternative Cost Method of Evaluation

Let P and G refer respectively to the costs (assumed constant) of the private and the public alternatives. In this case, tantamount to assuming completely inelastic demand at output E or fixed scale of plant, the only issue is one of comparative costs. Since output E or fixed scale of plant, the only issue is one of comparative costs. Since output E will be provided regardless of the alternative selected, the concern is with providing goods or services at the cheapest cost. Gross benefit or gross willingness-to-pay is indicated by the area OEDP while net benefit as net willingness-to-pay is reflected in the area PDRG. Thus, level G represents the maximum willingness to pay for E units with the net benefits estimated by the reduction in costs associated with the public alternative.

Another case is that in which a higher cost private alternative exists which would be implemented in the absence of the public alternative. Assuming that neither alternative need be built to a fixed scale and allowing for a demand schedule which is not totally inelastic, the optimum level of public provision would be at level W in Figure 1 (This follows from the rule of setting marginal benefit equal to marginal cost, as discussed in paper 3).

In this case, the demand function would have to be estimated between the points D and F in Figure 1. Benefits from public provision of output level E are limited by the private cost OPDE. Because of the greater quantities demanded at the lower cost, benefits must also include the area DFR. Thus, OP, the cost of the private alternative, represents the upper bound of willingness-to-pay for the public alternative or the upper bound to benefits.

A third case is one in which both G and P are public projects. In the event that the two alternatives represent outputs provided by two different agencies (i.e., if one does not provide the service the other will), the alternative cost technique can be applied just as described previously. In this manner, the criterion is once again one of comparative costs in which the demand function need not be estimated.

The primary strength of the alternative cost technique is that it does allow, in certain circumstances, estimation of maximum willingness-to-pay without actually estimating demand functions. So long as demands are relatively inelastic the technique can be very useful.

The principle limitation of the technique lies in the selection of the "most likely alternative". It is always possible to formulate an alternative project which is more expensive than the proposed plan, and which will therefore yield and estimate of net beneficial effects. Therefore, it must be required that society would, in fact, undertake the alternative means (i.e., the alternative must itself be economically feasible) in order to assure that a proper measure of net beneficial effects is in fact achieved.

The alternative cost procedure is typically utilized in the cases of urban water supply, urban flood damage alleviation, electric power, transportation and fishery enhancement.

Valuation of Increases in Output from External Economies

Individual firms or industries directly affected by the plan may provide beneficial effects for related producers or consumers. It was argued in the earlier NED session that the relationships must be "technological" to justify the impacts being included in the NED account, for only technological externalities yield changes in real national welfare.

In principle, the measurement of external economies is straight-forward. In keeping with the assumption that beneficial (and adverse) effects are measurable in money values, we can say that the beneficiary would be willing to pay some positive amount rather than go without the benefit. The amount he is willing to pay is the appropriate measure of the value of the external effect. As with direct output increases, the willingness-to-pay may be difficult to determine in practice. We would expect to employ the various techniques discussed above to approximate WTP, including simulation of market prices, change in net income and cost of most likely alternative.

The writer is of the opinion that technological external economies are not likely to be a significant concern in water related planning activities. First, the significant water-related externalities have, over time, been formally internalized in the planning process. For example, storage reservoirs for flood control clearly provided external benefits in such diverse forms as capacity for hydro-power generation, water supply, recreation, and so forth. These project "purposes" have become incorporated into formal planning procedures. Hence, a significant class of external economies are already explicitly accounted for in our system of multi-purpose project planning.

Second, the existence of external economies-unpriced beneficial effects-in the private sector signal the existence of non-exploited profit possibilities. Bargains may be reached among the affected parties, or the external effects may be internalized through formal merger of the firms involved in the interdependency.

Special Treatment of Unemployed or Underemployed Resources

At the conceptual level, as was seen in the earlier session, it is customary to treat the effects of using unemployed resources by an adjustment to adverse effects. This follows from the assumption that resource costs should be measured in terms of social opportunity cost rather than market price in cases where these constraints differ. Where resources are not fully employed, market prices or wage rates are likely to overstate the true opportunity cost of the resource.

However, since difficulties arise in cost allocation and cost sharing computations, the effects of employing unemployed resources is to be credited to the beneficial impacts accounts, rather than as a deduction from market cost of resources in the adverse effects accounts.

Due to difficulties in measuring the effects of programs or unemployment over the life of a long-term project, the Principles and Standards permit such adjustments only as related to expenses incurred during the project construction and installation period.

(Haveman and Krutilla describe a detailed procedure for determining both direct and indirect adjustments for unemployed labor resources. See list of references for full citation).

Measuring Adverse Effects on National Economic Development

Adverse effects include two types: (a) resources required or displaced to produce final or intermediate goods or services, and (b) decreases in output due to external diseconomies. A special case arises in the treatment of unemployed or underemployed resources.

A. Resource Costs

Where physical structures are required to achieve program objectives, money outlays will be required to purchase the labor, capital and perhaps the site necessary to construct and operate the project. All actual expenditures for goods and services, as well as transfer costs and interest during construction, are to be determined. By and large, measurement of these goals poses no particular problems, in that market values are, with the exception of unemployed resources noted previously, taken as measures of resource costs.

B. Measuring Effects of Output Decreases from External Diseconomies

Technological external diseconomies are non-priced adverse effects on others rather than the direct project beneficiaries. The effects of this class of externalities in the NED account are measured by the amount the recipients would have to be paid to induce them to put up with the spillover. Many, if not all, of negative spillovers will be also treated in the Environmental Quality accounts. Economists typically classify degradations of air, water or open space from production of consumption activities as technological external diseconomies, while ecologists surely regard these effects as reductions in Environmental Quality. Hence, the possibility for double-counting (in sense of measuring impacts in more than one account) must be faced.

As to procedures for measuring or approximating willingness of those adversely affected to avoid the damages, the general procedures for estimating WTP discussed in the sectors on direct outputs can be brought into play.

In the case where the recipients are producers, the change in net income approach is appropriate. For example, impacts of saline irrigation return flows on downstream farmers have been successfully treated by this method.

The dollar value of degradation of industrial and household water supplies has been measured by a concept akin to the alternative cost procedure, in that added costs of treatment (e.g., softening) or costs of industrial process changes are used to measure willingness-to-pay to avoid reductions in output or utility.

Although the techniques are admittedly in the experimental stage, efforts have been made to impute willingness-to-pay to avoid damages by simulating market prices either by measuring impacts on land values, or direct questioning of those suffering damages. The same limitations regarding these techniques which were noted in the discussion under measuring direct beneficial impacts would apply here.

Summary and Conclusion

The willingness-to-pay concept provides a measure by which the beneficial or adverse NED-related effects from any project purpose can be expressed in common terms, namely in dollar values. A program will provide a net contribution to the National Economic Development objective if the present value of the willingness of program beneficiaries to pay for program outputs (benefits) exceeds the present value of willingness of these or other consumers to pay for the use of the resources in some other activity (costs). The willingness of users or consumers to pay for resources or outputs is postulated to be negatively related to the quantity available. Hence, willingness-to-pay is represented in conceptual discussions by the demand function, which relates price and quantity, via a curve which slopes downward to the right.

Actual demand curves for program outputs are rather difficult in practice to derive. Hence, measurement of beneficial and adverse effects in the NED account, for the most part, involves applying analytical procedures which are approximations to the desired concept. This lecture provided a brief introduction to the major approaches used in measuring economic (i.e., NED) impacts, including (a) the use of actual or simulated market prices, (b) change in net income, and (c) cost of most likely alternative.

Selected References:

Dasgupta, A.K. and D.W. Pearce, Cost-Benefit Analysis, Harper, New York (1972).

Harberger, A.C., "Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay". Journal of Economic Literature. Vol. IX, No. 3. (September 1971).

Haveman, Robert and John V. Krutilla. Unemployment, Idle Capacity and the Cost of Public Investment. Baltimore: Johns Hopkins Press. (1968).

Herfindahl, O.C. and A.V. Kneese. Economic Theory of Natural Resources. Merrill Publishing Co., Columbus, Ohio (1974).

Howe, C.W. Benefit Cost Analysis for Water System Planning. Monograph 2, American Geophysical Union. (1971).

James, L.D. and R.R. Lee. Economics of Water Resources Planning. McGraw-Hill, New York. (1971).

Knetsch, J.L. Outdoor Recreation and Water Resource Planning. Monograph No. 3, American Geophysical Union. (1974).

Young, R.A. and S.L. Gray. The Economic Value of Water. Technical Report to National Water Commission. (1972).

PRINCIPLES AND STANDARDS REQUIREMENT FOR THE MEASUREMENT OF EFFECTS OF WATER AND RELATED LAND RESOURCE PLANS ON ENVIRONMENTAL QUALITY

Gary L. Hickman
U.S. Water Resources Council*
Washington, D.C.

The measurement of Environmental Quality (EQ) effects stems from the requirements stated in the Principles and Standards (P&S) which are:

> "For each alternative plan there will be a complete display or accounting of relevant beneficial and adverse effects on the national economic development and environmental quality objectives. Alternative plans will be formulated to optimize their contributions to the two objectives.
>
> Beneficial and adverse effects are measured in both monetary and nonmonetary terms. Estimating these beneficial and adverse effects is undertaken in order to measure and display in appropriate accounts the net changes with respect to particular objectives that are generated by alternative plans" (p. 35).

also:

> "A water and land use plan may have a variety of effects . . . beneficial and adverse . . . on environmental quality. While effects on environmental quality are characterized by their nonmarket, nonmonetary nature, they provide important evidence for judging the value of proposed plans.
>
> Beneficial effects on the environmental quality account are contributions resulting from the management, preservation, or restoration of one or more of the environmental characteristics of an area under study or elsewhere in the nation. Such contributions generally enhance the quality of life.
>
> Adverse environmental effects--generally the obverse of beneficial environmental effects--are consequences of the proposed plan that result in the deterioration of relevant environmental characteristics of an area under study or

---

*At the time this paper was prepared, the author was employed by the U.S. Fish and Wildlife Service, Department of the Interior.

> or elsewhere in the Nation, for example, acres of open and green space, wilderness areas, estuaries, or wildlife habitat inundated or altered, or of lands experiencing increased erosion. Such adverse effects generally detract from or diminish the quality of life" (pp. 59 and 60).

While the above generally highlights the need for the EQ measurement requirements, it would be well to first recap the definition of environmental quality objective and its components as presented in the P&S before considering the actual procedures for measuring EQ effects.

The National Environmental Quality objective, as defined in the P&S -

> ". . . is enhanced by the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural and cultural resources and ecological systems in the area under study and elsewhere in the Nation. This objective reflects society's concern and emphasis for the natural environment and its maintenance and enhancement as a source of present enjoyment and a heritage for future generations.

and continues as follows:

> . . . the environmental objective reflects man's abiding concern with the quality of the natural physical-biological system in which all life is sustained" (p. 33).

The measurement of effects of any particular plan on environmental quality under the P&S is limited to the natural, physical, historical, biological environment. The measurement of effects does not include the human environmental features such as the short term improvements in living conditions brought about by a reduction in flooding of the human environment.

A basic requirement of the Principles and Standards is a "with plan" and "without plan" analysis basis for determining net beneficial and adverse effects. Precise wording of the with and without requirement in the Principles and Standards is:

> "In planning water and land resources, beneficial and adverse effects of a proposed plan should be measured by comparing the estimated conditions with the plan with the conditions expected without the plan. Thus, in addition to projecting the beneficial and adverse effects expected with the plan in operation, it is necessary to project the

> conditions likely to occur in the absence of a plan. Economic, social, and environmental conditions are not static, and changes will occur even without a plan. Only the new or additional changes that can be anticipated as a result of a proposed plan should be attributed as beneficial and adverse effects of the plan" (p. 36).

The above quotations from the Principles and Standards serve to provide the foundation for the treatment of I. Measurement of Effects of Alternative Plans on components of the Environmental Quality Objective (p. 3), II. A Case Example of an: (1) Abbreviated NED-EQ Evaluation Account; (2) An Abbreviated EQ Plan and (3) Evaluation Account (p. 45), and III. Significance of the Measurement of Effects of Alternative Plans on Environmental Quality (EQ Evaluation Account) in Water and Related Land Resources Planning (p. 67).

I. Measurement of Effects of Alternative Plans on Components of the Environmental Quality Objective

The P&S for planning for water and related land resources requires the consideration of the following components of the Environmental Quality objective:

- Physical Land Resources
  - Soil Stability
  - Geological Resources
- Air and Water Quality
  - Air Quality Standards
  - Water Quality Standards
- Ecological Resources
  - Terrestrial Ecosystems
  - Aquatic Ecosystems
  - Special Ecosystem Relationships and Irreversible Commitments of Resources
  - Species Threatened with Extinction
- Culturally Significant Resources
  - Archeological Resources
  - Historical Resources
  - Areas of Natural Beauty

By gathering data and analyzing information on the above components, at least two distinct beneficial results occur:

1. It makes it possible for the public, decisionmakers, and the planners to bring into sharp focus the significant environmental issues and needs.
2. It will lead to better interagency coordination because the type and kind of information gathered is of direct concern to the involved agencies of the Federal Government.

Some of the general methods for actually measuring EQ effects will now be considered. To do this effectively, quotations from the P&S (the underscoring is added) specifically relating to each of the EQ components - itemized above and discussed below in more detail - are given and followed by some methods for measuring effects on EQ.

A. Physical Land Resources

1. Soil Stability - (Land Quality)

"Enhancement of quality aspects of . . . land . . . by control of pollution or prevention of erosion and restoration of eroded areas . . ." (p. 34, P&S).

"Land quality. Where erosion is prevalent or spreading--largely because of inadequate land use planning and management--it, among other things, seriously detracts from the general use, appreciation, and enjoyment of terrestrial and aquatic environments.

"As encompassed in the environmental quality objective, soil is valued as a basic national resource rather than for its more traditional role as a primary production factor contributing to increases in national output".

Beneficial erosion control effects improving the visual attractiveness of the natural landscape include:

a. Reductions in sediment on beaches and public recreation areas;

b. Reductions in turbidity and sediment pollution of water in rivers, streams and lakes;

c. Restoration of cull banks from strip mines and other eroded sites;

d. Bank stabilization on mainline and secondary roads". (pp. 74, 75).

The U.S. Soil Conservation Service (SCS) has developed methods of evaluating soil losses on farm lands; construction sites; stream banks, channels, and roadside ditches as follows:

Erosion on farmland may be affected by planned projects. Where new land is brought into production, especially sloping land, or where land will be farmed more intensively, erosion may be increased unless erosion control practices are used. On the other hand, where the plan provides for less intensive farming of sloping land or specified erosion control practices are implemented on farmland, erosion may be substantially reduced.

The Universal Soil Loss Equation is used to calculate the tons of soil loss per acre. The calculations of such are objective measures based on developed coefficients. The application of this equation by SCS requires the following data:

- The soil erodibility factor (K). K factors are based on key soil properties and have been assigned by the SCS to each of the soils in the United States.
- The cropping system factor (C), or sequence of crops, to be grown.
- The conservation practice factor (P), which takes into account practices such as contouring, terracing, contour strip cropping, minimum tillage, etc.
- The slope length factor (L).
- The slope steepness factor (S).
- The rainfall intensity factor (R).

Of the factors in the equation, K and S are determined from soil surveys; L is determined either from onsite inspection or estimated from soil survey and topographic surveys; R is determined from a national map of rainfall intensity factors available through the Soil Conservation Service; C and P are determined by onsite inspection or may be estimated for the watershed data available from the Conservation Needs Inventory. Commonly, due to variations in slope or other limiting soil properties, C and P vary according to the kind of soil or according to groups of similar soils. The unique combinations of K, S, L, C, and P in the watershed, and the acreage of each must be estimated.

Delivery ratios are applied to the total erosion calculated in order to determine estimates of the total sediment reaching the stream at various points in the watershed. No arbitrary equation exists for computing the delivery ratio. It is commonly estimated in broad classes for wide regions of the country.

The procedures for application of the Universal Soil Loss Equation are described in the following publications:

Wischmeir, W.H., C.B. Johnson, and B.V. Cross. 1971. A soil erodibility monograph for farmland and construction sites. Journal Soil and Water Cons. 26: 5: 189-193.

Agricultural Research Service. 1965. Predicting rainfall-erosion losses from cropland east of the Rocky Mountains. Agr. Handbook No. 282. U.S. Government Printing Office, Washington, D.C.

Erosion on construction sites or areas of surface mining may be very severe when intense rainfall occurs on soil surfaces that lack protective vegetative cover. The procedure discussed above is also appropriate for estimating erosion from construction sites, except that the calculated soil loss must be factored downward where soil lacks vegetative cover for periods of less than a full year.

The construction of sediment basins to receive runoff from construction sites, and hold it sufficiently long for much of the suspended sediment to settle out, is an effective method of reducing the pollution of surface water. Also, establishing vegetative cover as soon as possible after construction, or during intermediate periods within the construction period is also effective, as are minimizing the area disturbed and using surface mulches of organic or other material.

Erosion of stream banks, channels, and roadside ditches may produce large volumes of sediment which will pollute lakes or streams and shorten the useful life of reservoirs. Such erosion may also be so severe as to impair the functions of the roadway or destroy land adjacent to the stream channel. Estimates of the volume of sediment created are commonly based on site inspections, on a random sample basis, whereby data is developed for average erosion per unit length of the channel or ditch. Variables considered include the erodibility of the soil or geologic strata, the shape of the channel or ditch, and the volume, velocity, and abrading quality of the water and its suspended solids. Data from the sample areas are extrapolated arithmetically to the full length of the channel or ditch.

2. Geological Resources

> "Management, preservation or enhancement of especially valuable or outstanding . . . geological resources . . ." (p. 34, P&S), ". . . contributes to man's knowledge and appreciation of his physical environment" (p. 70, P&S).

With regard to the above statement, a partial list of geolcgical measurement parameters paraphrased from pp. 70-71 is as follows:

"Size and measure:

(1) Surface acreage
(2) Subsurface acreage (estimated)
(3) Quantity (volume and frequency of occurrence)

A descriptive-qualitative interpretation, including an evaluation of the effects of a plan on the designated or affected geological resources. This includes evaluation of effects of construction or men induced alteration on volcanoes, mountains, glaciers, etc.

Educational:

(1) General education
(2) Special and scientific

Improvements:

(1) Accessibility (including land acquisition for public roads and trails; easements)
(2) Interpretation and monumentation
(3) Other (specify and describe

Protection and preservation:

(1) Physical
(2) Legal (dedication, other)
(3) Special

Specific items that should be evaluated, if of geomorphic or geologic significance, are: caves, classic rock formations, classic stratigraphic rock section and unique palaeontological sites and unique geologic features such as natural bridges, etc.

B. Air and Water Quality

1. Air Quality

"Enhancement of quality aspects of . . . air by control of pollution . . ." (p. 34).

"Air quality. Air pollution is primarily a regional problem stemming principally from urban centers containing concentrations of people, industry, and transportation. In addition to its diverse social impacts, air pollution causes direct injury to natural environments, including ground cover, trees, and wildlife. In its purely physical dimensions, air pollution is accommodated within the environmental objective.

Beneficial effects to the environmental objective from air quality control may be defined in relation to regional air quality standards established under the Clean Air Act of 1970.

Consistent with air quality standards established for the affected planning area, air quality control beneficial effects are identified, measured and described by:

a. The amount and use of open space between sources of air pollution and concentrations of people to assist in the process of atmospheric dispersion and dilution.

b. Reductions in the use of fossil fuels.

c. Reductions in damages to:

(1) Wildlife - species, number or density, distribution, a descriptive-qualitative interpretation and evaluation of effects as appropriate.

(2) Ground cover - species, acreage and density, distribution, a descriptive-qualitative interpretation and evaluation of effects as appropriate.

(3) Forests - species or types, acreage, growth rates, distribution, a descriptive-qualitative interpretation and evaluation of effects as appropriate.

aesthetic appeal of natural settings and scenic landscapes" (pp. 73 and 74).

2. Water Quality

"Enhancement of quality aspects of water . . . by control of pollution . . ." (p. 34).

"Water quality - The beneficial effects of water quality improvements will be reflected in increased value to water users and will be recorded under the national economic development or regional development objective. For example, increases in the value of the Nation's output of goods and services from improvements in water quality will be accommodated

> under the national economic development objective. A great deal of improvement is needed in the methods of measuring these values.
>
> "There will be other water quality beneficial effects, however, that cannot be measured in monetary terms but are nonetheless of value to the Nation. Examples of such benefits are usually in the aesthetic and ecological areas so important to mankind. Beneficial effects from these kinds of improvements are contributions to the environmental quality account and are identified, measured, and described in nonmonetary terms".
>
> "Beneficial effects to the environmental quality account from water quality control may be defined in relation to the State standards or goals established under the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500)". (p. 72).

The Environmental Protection Agency (EPA) points out that the legislated water quality goals as specified in the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA), Section 101, are the attainment of water quality for protection and propagation of fish, shellfish, and wildlife and to provide for recreation in and on the water by July 1, 1983, and by 1985 the discharge of pollutants in navigable waters is to be eliminated.

Under the without plan, analysis of the water quality criteria would be defined in terms of use-classification and actual numerical criteria by river, lake, and stream segment. The criteria would include such parameters as Dissolved Oxygen (DO), temperature, Total Dissolved Solids (TDS), etc.

Basic assumptions and approaches for determining present water quality should be documented. Inventories should include locations and loadings of major point and non-point sources of water pollution. Inventories of water quality and affected aquatic biota at key locations in the aquatic ecosystem should be conducted. Pertinent stream flow characteristics would be considered representative for a segment of the river, lake, or stream. Minimum stream flow characterics would include:

- . Low flow frequency and duration
- . High flow frequency and duration
- . Critical flow conditions for water quality (high or low)

Under the with project analysis, the beneficial and adverse water quality effects (short term, long term, irreversible, and irretrievable) covering all parameters included in the Water Quality Standards and other relevant parameters should be determined. Tradeoffs between short-term environmental gains and long-term losses or vice versa should also be determined.

Examples of long-term effects are--eutrophication, ground-water pollution, salt water intrusion, salinization, and entrainments must be addressed.

Examples of irreversible and irretrievable commitments are--consumptive water uses, mining of ground water supplies, etc.

Sources of information, methods used for predicting water quality impacts of actions, and units of measurement utilized in the determination should be documented.

C. Ecological Resources

> "Management, preservation, or enhancement of especially valuable or outstanding . . . biological (including fish and wildlife habitat) . . . and ecological systems;" (p. 34).

A discussion and evaluation of the terrestrial and aquatic ecosystems is very important to the full understanding of the Environmental Quality measurement effects of this particular component.

1. Terrestrial and Aquatic Ecosystem Evaluation

The U.S. Fish and Wildlife Service in concert with State fish and wildlife agencies and private conservation organizations has developed a rigorous with and without plan analysis for terrestrial and aquatic ecosystems. A common denominator called "Habitat Units" (HU) has been developed as a unit of measure for each ecosystem. Habitat units reflect the value of each habitat type on a scale of 1 to 10 per acre for the full range of fish or wildlife. The future without project analysis calculates the effects of future land-use changes, human activities and plant community successions on habitat values over the period of analysis. With this without plan data base, the effects of any proposed action can be evaluated in terms of habitat units lost or gained for the terrestrial ecosystem (Figure 1). A separate analysis is made of the aquatic ecosystems.

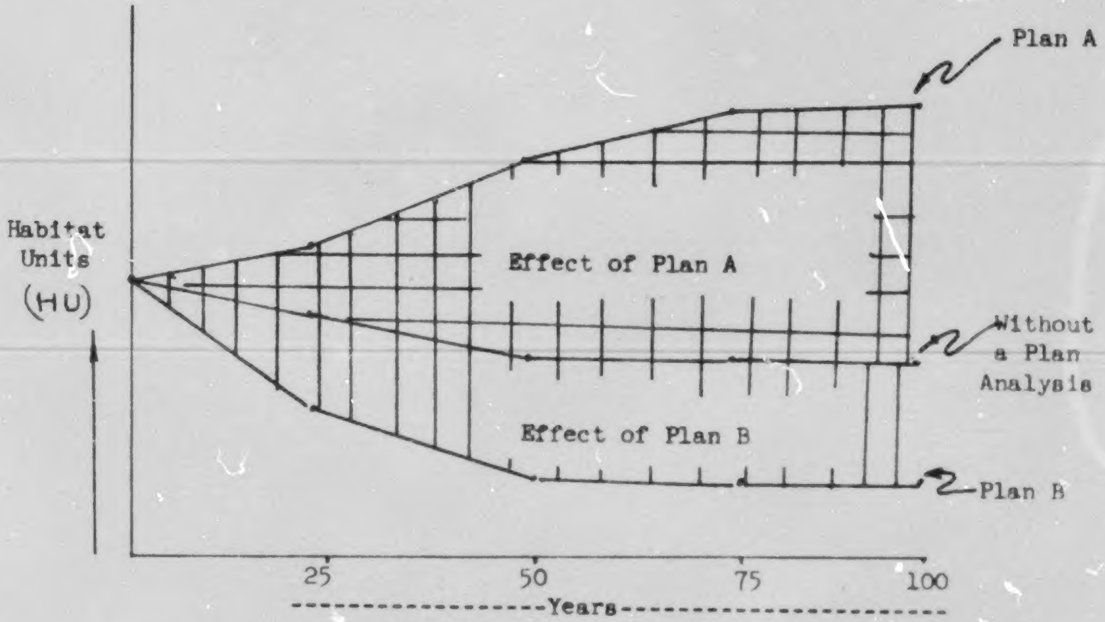


Figure 1. Graphically illustrating the measurement of effects of alternative plans on ecological resources.

In addition to this display of HU lost or gained, a narrative treatment will be made on special ecosystem relationships and irreversible commitments of ecological resources, and species of animals or plants threatened with extinction.

The Principles and Standards provide for thirty-two (32) major activities in the planning process (Figure 2). The chronological sequence of the measurement of the effects of alternative plans on environmental quality are described by the following grouping of phase activities:

Pre-Plan Formulation Activities

. Review of earlier higher level planning efforts if any (Activity 1)

. Review of published and documented materials relevant to the components of the two national planning objectives (Activities 2 to 7)

. Existing without plans EQ inventory and evaluation (Activity 8)

. Economic, population and land-use projections (Activity 9)

. Future without plans EQ evaluation--note at this point that land-use and human activities (Activity #9) projections have to be developed before the future without plans EQ evaluation can be developed (Activity 10)

. Specification of component needs of the EQ objective (Activity 11)

- Evaluation of NED resource capabilities without any plans (Activity 12)
- Specification of the component needs of the NED objective (Activity 13)
- EQ planning aid report to NED plan formulation subteam summarizing the without plan EQ evaluation (Activity 14)

Plan Formulation Activities

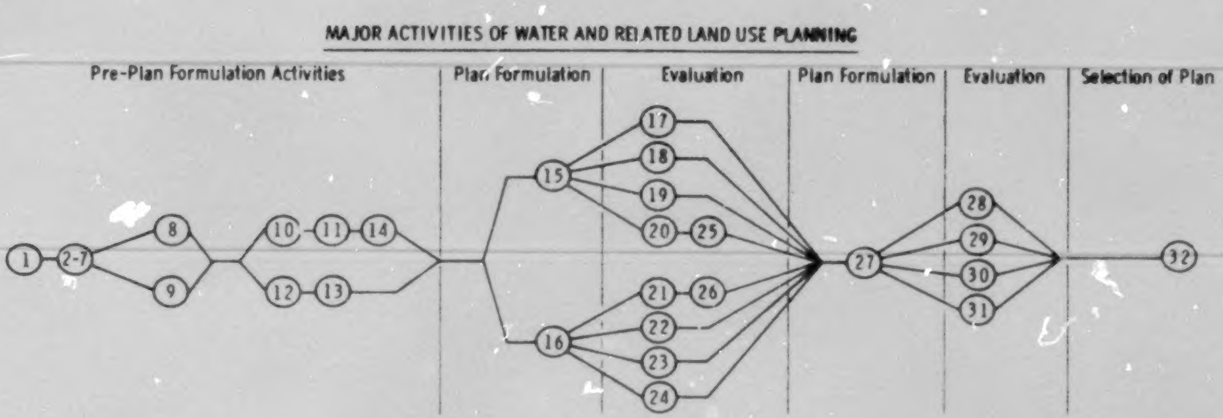
- The second major phase is the actual process of formulating the first EQ and NED plans (Activities 15 and 16)
- The third major phase in the planning process requires the evaluation of the EQ and NED plans (Activities 17 to 26).
- The fourth major phase of the planning process is multi-objective plan formulation (Activity 27).
- The fifth major phase is evaluation of multi-objective planning (MOP) (Activities 28 to 31).
- The sixth and final major phase of the planning process is selection of recommended plan (Activity 32)

Calculations for Plan Evaluation

Having reviewed the above pre-plan and plan formulation activities, the measurement or evaluation of the effects of an alternative plan on ecological resources will be traced through the planning process starting with Activity #4.

Activity #4 requires review and summarization of the existing documentation on flora and fauna including the life history requirements and ecosystem dynamics for the planning area. If specific documentation is not available for the planning area, then pertinent materials at the State, region and/or National levels should be reviewed and summarized. Data should be collected on the following ecological indicators:

- Terrestrial Ecosystems. Special attention should be given to the food and cover requirements for the following specific indicators:
  - -Big Game Mammals
  - -Upland Game Mammals
  - -Furbearing Species
  - -Other Mammals
  - -Upland Game Birds
  - -Waterfowl
  - -Other Water and Marsh Birds
  - -Other Birds
  - -Reptiles and Amphibians
- Aquatic Ecosystems. Special note should be taken of the following indicators:
  - -Phsyical Characteristics
  - -Chemical Characteristics
  - -Biological Characteristics



1. Review Level A and B projections and requirements for planning area.
2. Review of documented physical land resources (soil stability and geological resources) in planning area.
3. Review documented air and water quality in planning area.
4. Review documented ecological resources in planning area.
5. Review documented culturally significant resources in planning area.
6. Review other NED planning in area.
7. Review RD and SWB planning by other entities.
8. Existing without plans inventory and evaluation of EQ components in planning area.
9. Set economic and population and land use projections in planning area.
10. Future without plans evaluation of EQ components.
11. Specify component needs of Environmental Quality Objective for the planning area.
12. Evaluate NED resource capabilities without any plans.
13. Specify component needs of the NED objective for planning area.
14. EQ planning aid report to NED formulation subteam.
15. EQ plan formulation.
16. NED plan formulation.
17. EQ Plan--NED evaluation account.
18. EQ Plan--RD evaluation account.
19. EQ Plan--SWB evaluation account.
20. EQ Plan--EQ evaluation account.
21. NED Plan--EQ evaluation account.
22. NED Plan--NED evaluation account.
23. NED Plan--RD evaluation account.
24. NED plan--SWB evaluation account.
25. Compensation needs--for EQ Plan.
26. Compensation needs--for NED Plan.
27. MOP(s) formulation.
28. MOP--EQ evaluation account.
29. MOP--NED evaluation account.
30. MOP--RD evaluation account.
31. MOP--SWB evaluation account.
32. Selection of Recommended Plan.

FIGURE 2. Thirty-Two Major Activities in the Planning Process for Planning Water and Related Land Resources

- Ecosystem Dynamics
- Species endangered or threatened with extinction

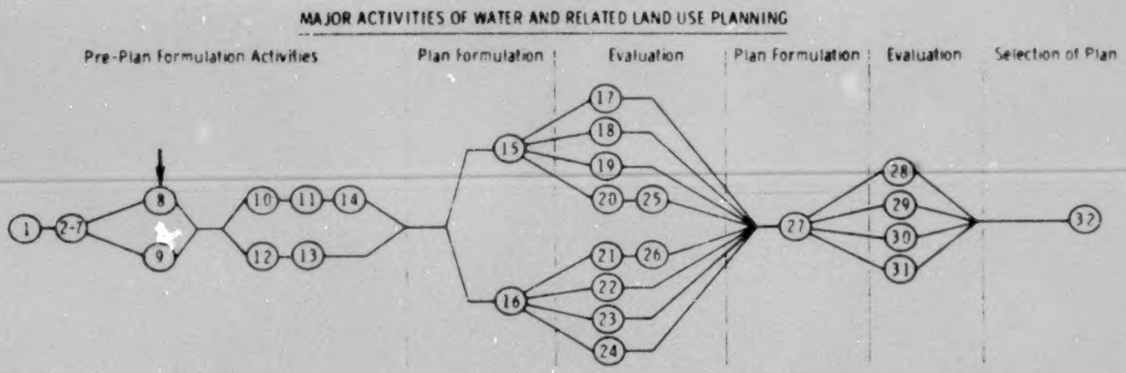
Activity #8 (Figure 3) is next in the planning process. It is the inventory of existing Ecological Resources without consideration of any plans for the area under study. The steps to take are:

- Identification of all terrestrial habitat-types and assign a two (2) digit numerical code (Figure 4)
- Classification of the aquatic ecosystem types and assign a numerical code.
- Selection of representative sample locations (minimum 3 to 5) for each habitat-type for the terrestrial and aquatic ecosystems, respectively.

Using Form #1 (Figure 5) the carrying capacity of each habitat-type is evaluated in terms of food and cover for each of the nine (9) major groups of vertebrate wildlife. As indicated previously, key habitat evaluation criteria for each primary species of each indicator group is converted on a scale of one (1) to ten (10) to reflect the habitat value. Further details of this evaluation example include:

- Vertical stratification of the bottomland hardwood forest into overstory, understory and ground vegetation. If the habitat-type had been grasslands - only the ground vegetation would require evaluation.
- Selection of three (3) geographic sites for evaluation of the bottom hardwood type forest.

Note that "NA" on Form 1 (and subsequent forms) means "not applicable" if the particular characteristic does not contribute to the species group under evaluation. After each major group of vertebrate wildlife has been evaluated for each habitat characteristic on the three (3) geographical sample sites, the columns are summed and the number of observations greater than zero is recorded. The grand total of the evaluation element value is the sum of these values. The grand total of observations made is calculated by summing the bottom row. The average habitat-type unit value is then calculated by dividing the grand total evaluation element value by the grand total number of observations. This means that wherever this habitat-type occurs in the planning area used in this example, its base value in habitat units is 5.8 per acre. Accordingly, this type of calculation needs to be conducted for each habitat-type in the planning area (Form 1, Figure 6).



1. Review Level A and B projections and requirements for planning area.
2. Review of documented physical land resources (soil stability and geological resources) in planning area.
3. Review documented air and water quality in planning area.
4. Review documented ecological resources in planning area.
5. Review documented culturally significant resources in planning area.
6. Review other NED planning in area.
7. Review RD and SWB planning by other entities.
8. Existing without plans inventory and evaluation of EQ components in planning area.
9. Set economic and population and land use projections in planning area.
10. Future without plans evaluation of EQ components.
11. Specify component needs of Environmental Quality Objective for the planning area.
12. Evaluate NED resource capabilities without any plans.
13. Specify component needs of the NED objective for planning area.
14. EQ planning aid report to NED formulation subteam.
15. EQ plan formulation.
16. NED plan formulation.
17. EQ Plan--NED evaluation account.
18. EQ Plan--RD evaluation account.
19. EQ Plan--SWB evaluation account.
20. EQ Plan--EQ evaluation account.
21. NED Plan--EQ evaluation account.
22. NED Plan--NED evaluation account.
23. NED Plan--RD evaluation account.
24. NED plan--SWB evaluation account.
25. Compensation needs--for EQ Plan.
26. Compensation needs--for NED Plan.
27. MOP(s) formulation.
28. MOP--EQ evaluation account.
29. MOP--NED evaluation account.
30. MOP--RD evaluation account.
31. MOP--SWB evaluation account.
32. Selection of Recommended Plan.

FIGURE 3. Existing Terrestrial Resources Inventory and Evaluation of EQ Components Without Any Plans (Activity #8)

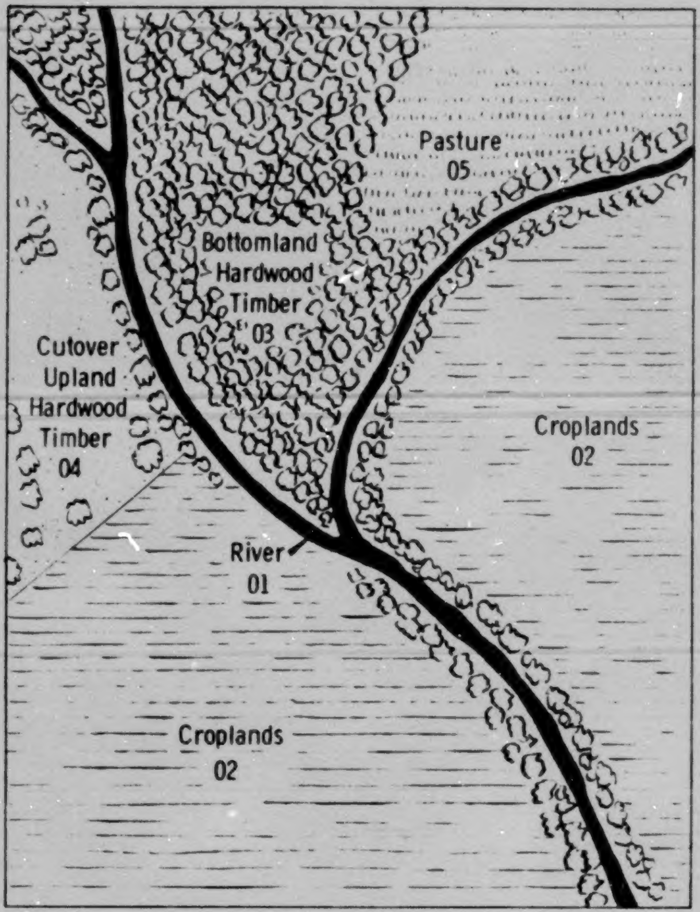
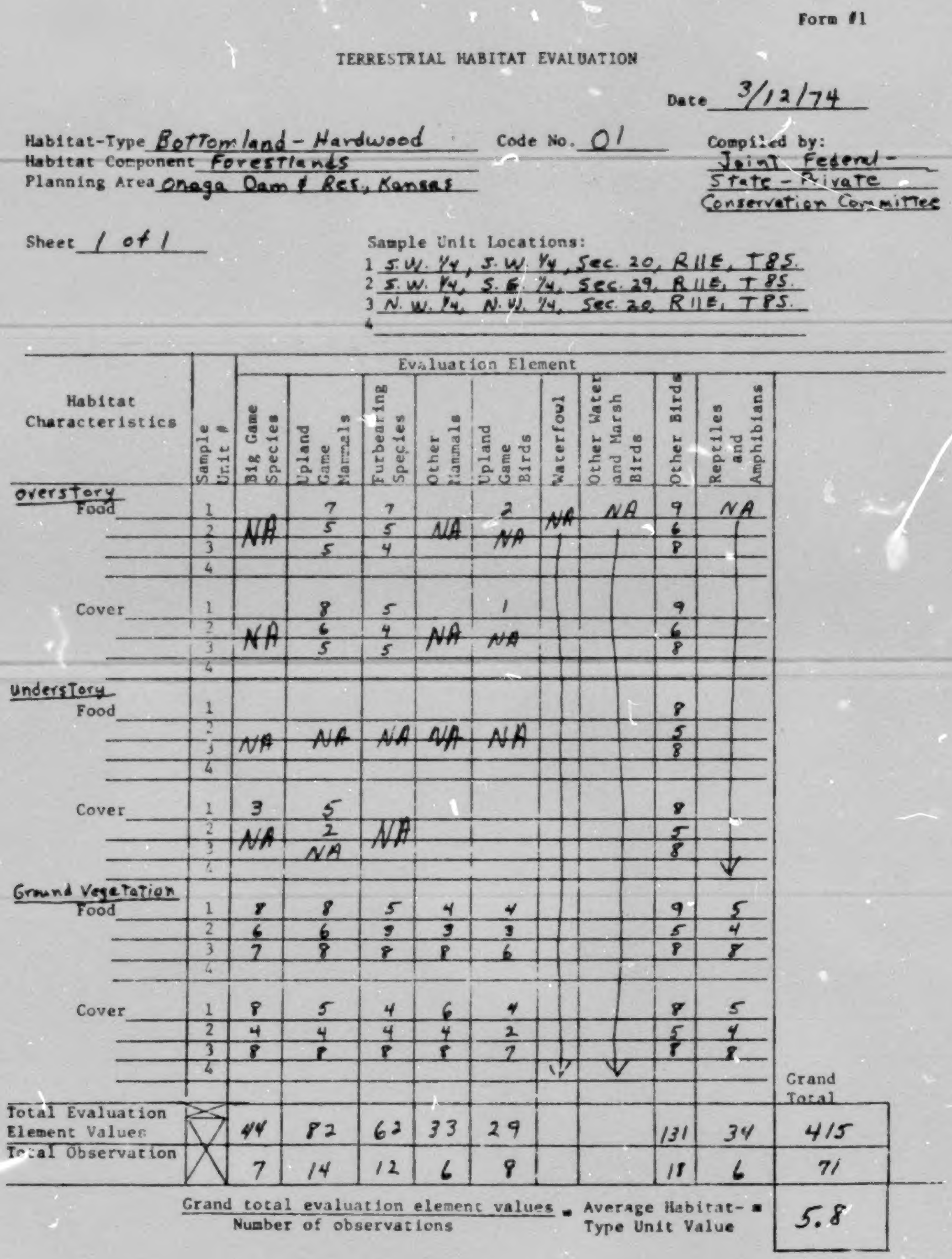


FIGURE 4. Identification of Terrestrial Habitat-Type



Form #1

TERRESTRIAL HABITAT EVALUATION

Date 3/12/74

Habitat-Type Bottomland - Hardwood
Habitat Component Forestlands
Planning Area Onaga Dam & Res., Kansas

Code No. 01

Compiled by: Joint Federal - State - Private Conservation Committee

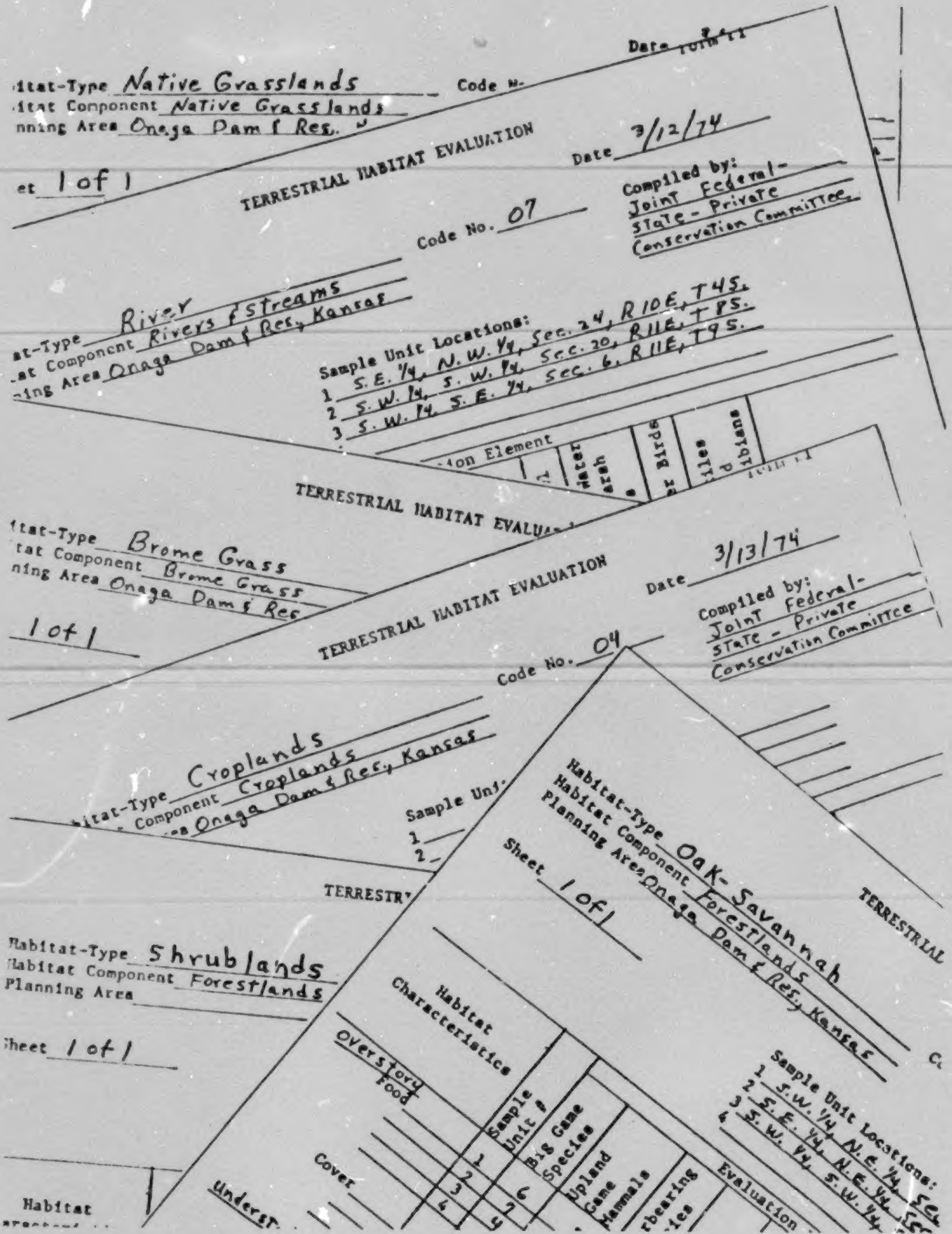
Sheet 1 of 1

Sample Unit Locations:
1 S.W. 1/4, S.W. 1/4, Sec. 20, R11E, T8S.
2 S.W. 1/4, S.E. 1/4, Sec. 29, R11E, T8S.
3 N.W. 1/4, N.W. 1/4, Sec. 20, R11E, T8S.
4

Habitat Characteristics	Sample Unit #	Evaluation Element									
		Big Game Species	Upland Game Mammals	Furbearing Species	Other Mammals	Upland Game Birds	Waterfowl	Other Water and Marsh Birds	Other Birds	Reptiles and Amphibians	
Overstory Food	1		7	7		2	NA	NA	9	NA	
	2	NA	5	5	NA	NA			6		
	3		5	4					8		
	4										
Cover	1		8	5		1			9		
	2	NA	6	4	NA	NA			6		
	3		5	5					8		
	4										
Understory Food	1								8		
	2	NA	NA	NA	NA	NA			5		
	3								8		
	4										
Cover	1	3	5						8		
	2	NA	2	NA					5		
	3		NA						8		
	4										
Ground Vegetation Food	1	8	8	5	4	4			9	5	
	2	6	6	3	3	3			5	4	
	3	7	8	8	8	6			8	8	
	4										
Cover	1	8	5	4	6	4			8	5	
	2	4	4	4	4	2			5	4	
	3	8	8	8	8	7			8	8	
	4										Grand Total
Total Evaluation Element Values	☒	44	82	62	33	29			131	34	415
Total Observation	☒	7	14	12	6	8			18	6	71

Grand total evaluation element values / Number of observations = Average Habitat-Type Unit Value = 5.8

FIGURE 5. Terrestrial Habitat Evaluation (Form #1), Field Rating by Habitat Characteristics and Faunal Group



Date Form #1
itat-Type Native Grasslands Code N
itat Component Native Grasslands
nning Area Onaga Dam & Res.
et 1 of 1

TERRESTRIAL HABITAT EVALUATION
Date 3/12/74
Compiled by: Joint Federal-State-Private Conservation Committee
Code No. 07
at-Type River
at Component Rivers & Streams
ning Area Onaga Dam & Res, Kansas
Sample Unit Locations:
1 S.E. ¼, N.W. ¼, Sec. 24, R10E, T4S.
2 S.W. ¼, S.W. ¼, Sec. 20, R11E, T8S.
3 S.W. ¼, S.E. ¼, Sec. 6, R11E, T9S.
ion Element
Water
arsh
r Birds
iles
ibians
Form #1

TERRESTRIAL HABITAT EVALUA
itat-Type Brome Grass
tat Component Brome Grass
ning Area Onaga Dam & Res
1 of 1

TERRESTRIAL HABITAT EVALUATION
Date 3/13/74
Compiled by: Joint Federal-State-Private Conservation Committee
Code No. 04
itat-Type Croplands
Component Croplands
ea Onaga Dam & Res, Kansas
Sample Uni
1
2
TERRESTR

Habitat-Type Shrublands
Habitat Component Forestlands
Planning Area
Sheet 1 of 1
Habitat

TERRESTRIAL
Habitat-Type Oak-Savannah
Habitat Component Forestlands
Planning Area Onaga Dam & Res, Kansas
Sheet 1 of 1
Sample Unit Locations:
1 S.W. ¼, N.E. ¼, Se
2 S.E. ¼, N.E. ¼, Se
3 S.W. ¼, S.W. ¼
4

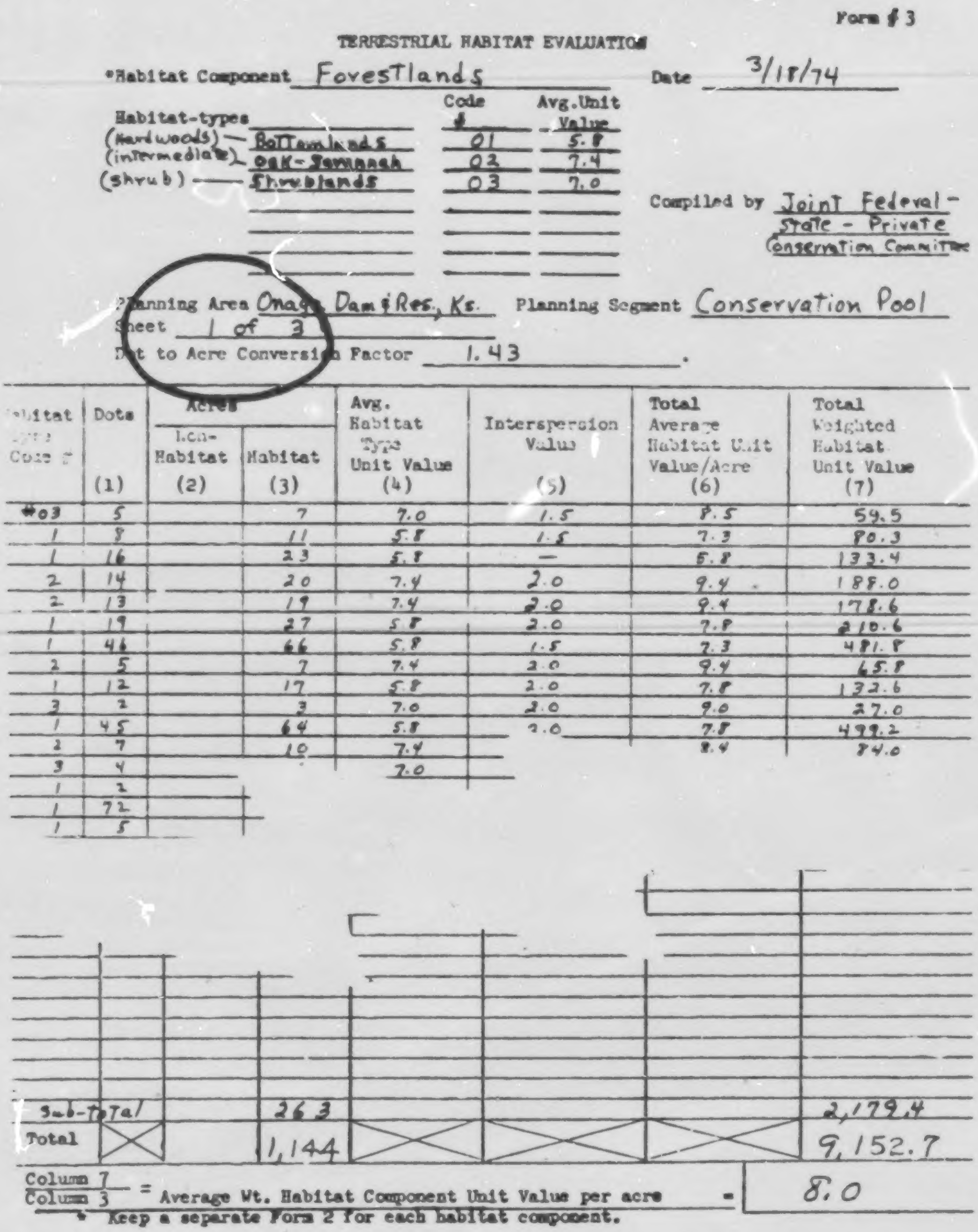
Habitat Characteristics	Sample Unit #	Big Game Species	Upland Game Mammals	rbearing cies	Evaluation
Overstory Food	1	6			
	2				
Cover	3	7			
Underst	4	4			

FIGURE 6. Terrestrial Habitat Evaluation (Form #1), Display of Habitat-Type

The next task is the determination of the acreage and total weighted value for each habitat component. First, an aerial mosaic of the planning area is stratified by the NED plan segments, or if the planning segments are not known, the planning area should be stratified by fifty (5) foot elevational contours depending on the homogeneity or randomness of the plant communities in each stratum. Each planning segment or elevational stratum is then grided into 40-acre squares and a dot grid system is used to determine the acreage and total weighted habitat unit value for each habitat component. These calculations are recorded on Form #3 (Figure 7). Also note that the average habitat unit value for each habitat type within the habitat component is transferred from Form #1 to the top of Form #3 and that the conversion factor from dot's to acres is 1.43. A detailed explanation of an example of how to use Form #3 (Figures 7 and 8) is as follows:

Let us assume that the first dots fell on shrublands, Code 03, of the forestland component and the number of dots recorded in column 1. The conversion factor of 1.43 times the number of dots equals 7 acres of shrubland habitat having a base value of 7 HU per acre. It is now essential to add an interspersion value on a scale of 0 to 3. The interspersion value among adjacent habitat types is based on their frequency of occurrence and quality in the grid sample. In this case example, the interspersion value is 1.5. Thus, this value plus the base value of 7.0 HU equals 8.5 the total average habitat unit value per acre for this point sample of 7 acres is the product of columns (6) and (3) or 59.5. This process is repeated for each occrrence of forestland types under a point sample using the dot grid system. Note that the interspersion value is zero on the third line entry. This means that no other habitat-type occurred in the 40-acre grid under evaluation.

Once the planning segment or geographic contour stratum has been dot grided and the total weighted habitat value calculated for each line entry, the acreage in column (3) and the total weighted habitat unit value in



Form # 3

TERRESTRIAL HABITAT EVALUATION

*Habitat Component Forestlands Date 3/18/74

Habitat-types	Code #	Avg. Unit Value
(Hardwoods) — Bottomlands	01	5.8
(intermediate) — Oak-Savannah	02	7.4
(shrub) — Shrublands	03	7.0

Compiled by Joint Federal-State-Private Conservation Committee

Planning Area Onaga Dam & Res., Ks. Planning Segment Conservation Pool

Sheet 1 of 3

Dot to Acre Conversion Factor 1.43.

Habitat Type Code #	Dots (1)	Acres Non-Habitat (2)	Acres Habitat (3)	Avg. Habitat Type Unit Value (4)	Interspersion Value (5)	Total Average Habitat Unit Value/Acre (6)	Total Weighted Habitat Unit Value (7)
#03	5		7	7.0	1.5	8.5	59.5
1	8		11	5.8	1.5	7.3	80.3
1	16		23	5.8	—	5.8	133.4
2	14		20	7.4	2.0	9.4	188.0
2	13		19	7.4	2.0	9.4	178.6
1	19		27	5.8	2.0	7.8	210.6
1	46		66	5.8	1.5	7.3	481.8
2	5		7	7.4	2.0	9.4	65.8
1	12		17	5.8	2.0	7.8	132.6
3	2		3	7.0	2.0	9.0	27.0
1	45		64	5.8	2.0	7.8	499.2
2	7		10	7.4		8.4	84.0
3	4			7.0			
1	2						
1	72						
1	5						
Sub-Total			263				2,179.4
Total			1,144				9,152.7

Column 7 / Column 3 = Average Wt. Habitat Component Unit Value per acre = 8.0

* Keep a separate Form 2 for each habitat component.

FIGURE 7. Terrestrial Habitat Evaluation (Form #3), Calculation of Average Weighted Habitat Unit Value Per Acre for Each Habitat Component

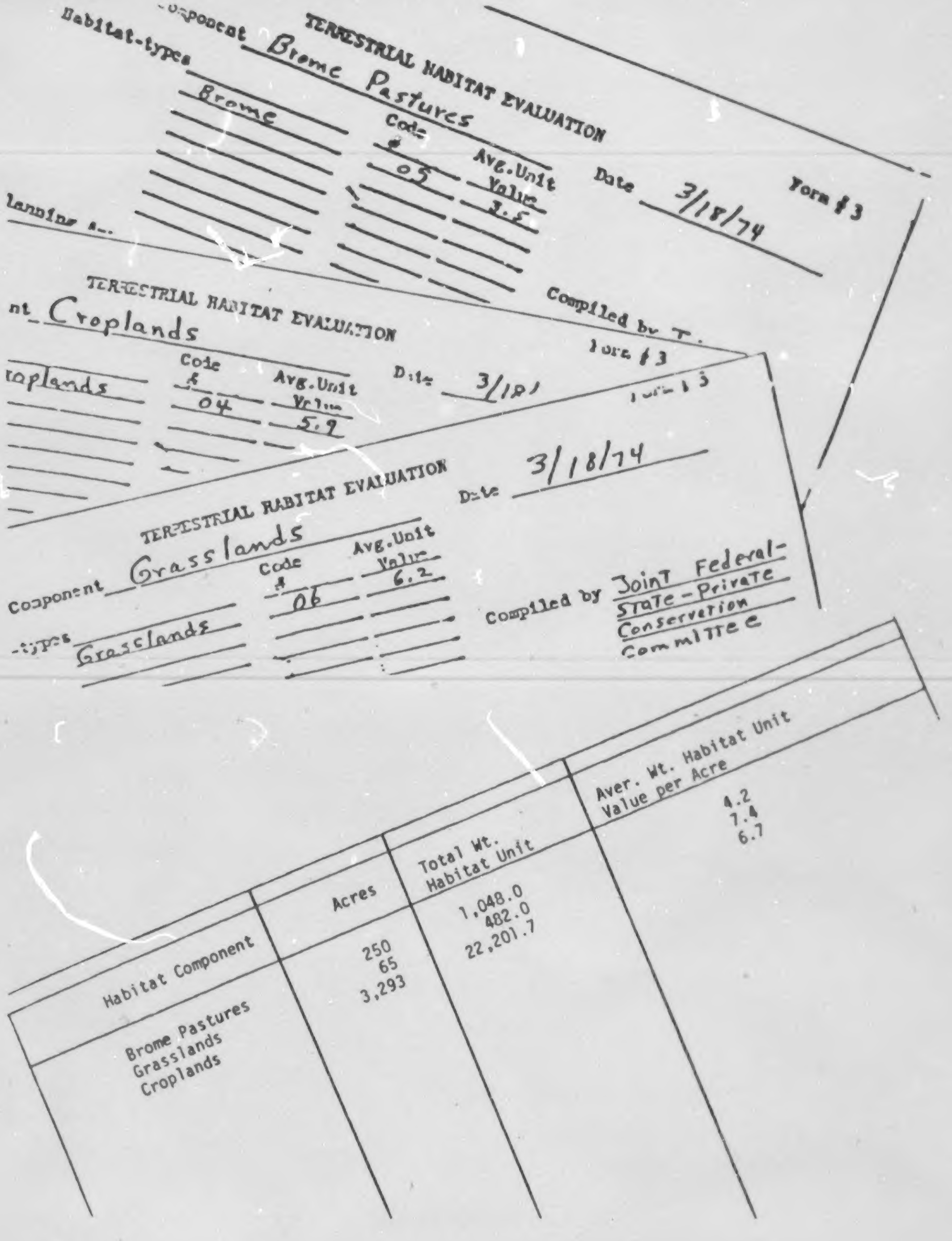
column (7) are summed vertically and recorded at the bottom of the form. The average weighted habitat component unit value per acre is calculated by dividing the summation of column (7) by the summation of column (3). Concurrently, the total weighted habitat unit values (Form 3, Figure 8) are calculated for the other habitat components as the dot grid point sample falls on them within the planning segment under evaluation.

Now, moving on to a detailed explanation of the calculations required for Form 4 (Figures 9, 10, 12, 16, 17) and the interrelationships of the terrestrial EQ component evaluations (Figures 11, 13, 14, 15):

On Form 4, Figure 9, the total acreages and average weighted habitat unit value per acre are recorded for each habitat component by planning segment from Form 3. Note for example, that the 250 acres of brome pastures, and its value of 4.2 HU per acre are recorded in columns (1) and (3). This transfer procedure from Form 3 to Form 4 should be followed for the rest of the habitat component acreage and HU values. Column (2) is an acreage adjustment column. In this case example the total acreage for the Conservation Pool and the Flood Pool were ten (10) percent under the total acreage calculated by the Army Corps of Engineers for each segment. For purposes of comparison, the acreages of each habitat component was proportionately increased and recorded in column (2). The evaluation process described above is carried out separately for each of the following planning segments:

. Conservation Pool
. Flood Pool
. Above Takeline Within One (1) Mile
. Below Dam Excluding Recreation Areas
. Recreation Areas Below Dam
. Recreation Areas Above Flood Pool
. Above Flood Pool to Takeline

Going now to the aquatic ecosystem aspects of Form 4, Figure 10, and using the basic aquatic habitat-types values developed on Form 2, the acreage and the aquatic habitat-type base value are recorded in columns (2) and (3) stratified by planning segments. The evaluation is made on physical, chemical and biological parameters. Note that the aquatic habitat types are:



TERRESTRIAL HABITAT EVALUATION

Form #3

omponent Brome Pastures

Date 3/18/74

Habitat-types

	Code #	Avg. Unit Value
Brome	05	3.5

lanning a..

Compiled by J

TERRESTRIAL HABITAT EVALUATION

Form #3

nt Croplands

Date 3/18/

	Code #	Avg. Unit Value
roplands	04	5.9

TERRESTRIAL HABITAT EVALUATION

Form #3

Date 3/18/74

Component Grasslands

-types

	Code #	Avg. Unit Value
Grasslands	06	6.2

Compiled by Joint Federal-State-Private Conservation Committee

Habitat Component	Acres	Total Wt. Habitat Unit	Aver. Wt. Habitat Unit Value per Acre
Brome Pastures	250	1,048.0	4.2
Grasslands	65	482.0	7.4
Croplands	3,293	22,201.7	6.7

FIGURE 8. Terrestrial Habitat Evaluation (Form #3), Display of Habitat Components

Form # 4

ALTERNATIVE PLAN EVALUATION BY PLANNING SEGMENT

Planning Area Onaga Dam & Res., Kansas
Alternative Plan A - NED plan
Sheet 1 of 2

Date 4/10/74
Summarized by Joint Committee
Terrestrial ☒
Aquatic ☐

Habitat Component by Planning Segment	Year	Acreage		Existing		% Habitat Units lost or gained per Acre	Habitat Units lost or gained per Acre (-or+)	Total Habitat Units lost or gained (-or+)	**Project Credits from private to public land ownership.		Total Net Habitat U lost or gained (- or +)
		From Form # 3 (Terr only)	Adjusted terrestrial and actual aquatic acreage	*Value per Acre	Total Habitat Unit Value				credits in unit per acre	adjusted habitat units lost or gained per acre	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Conservation Pool:											
Forest	0	1,144	1,273	8.0	10,184						
Crop	0	3,293	3,651	6.7	24,462						
Brome	0	250	277	4.2	1,163						
Native Prairie	0	65	73	7.4	540						
Rivers & Streams	0	46	46	7.2	331						
Total		4,798	5,320								
Flood Pool:											
Forest	0	1,239	1,405	9.1	12,786						
Crop	0	2,429	2,743	7.2	19,750						
Brome	0	614	693	4.5	3,119						
Prairie	0	348	393	7.7	3,026						
Streams	0	46	46	7.2	331						
Total		4,676	5,280								
Above Flood	Above takeline: ⊕										
Forest	25	835	929	9.1	8,454						
Crop	25	148	164	7.3	1,197						
Brome	25	133	148	4.6	681						
Prairie	25	5,218	5,798	6.8	39,423						
Streams	25	8	8	7.2	58						
Total		6,342	7,047								
Below Dam	(except Rec. Areas)										
Forest	0	233	259	7.9	2,046						
Crop	0	477	532	7.2	3,830						
Prairie	0	209	232	7.5	1,740						
Streams	0	17	17	7.2	122						
Total		936	1,040								

* Taken from Form # 3
** Applys only to terrestrial evaluation

FIGURE 9. Terrestrial Habitat Evaluation (Form #4), Acreage Adjustment and Calculation of Total Habitat Unit Values

Form # 4

ALTERNATIVE PLAN EVALUATION BY PLANNING SEGMENT

Planning Area Onaga Dam & Res., Kansas
Alternative Plan A - NED
Sheet 2 of 2

Date 4/10/74
Summarized by Joint Committee
Terrestrial ☒
Aquatic ☐

Habitat Component by Planning Segment	Year	Acreage		Existing		% Habitat Units lost or gained per Acre	Habitat Units lost or gained per Acre (-or+)	Total Habitat Units lost or gained (-or+)	**Project Credits from private to public land ownership.		Total Net Habitat U lost or gained (- or +)
		From Form # 3 (Terr only)	Adjusted terrestrial and actual aquatic acreage	*Value per Acre	Total Habitat Unit Value				credits in unit per acre	adjusted habitat units lost or gained per acre	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rec. Area below Dam:											
Forest	0	83	94	7.9	743						
Crop	0	167	183	7.2	1,318						
Prairie	0	70	78	7.5	585						
Total		320	355								
Rec. Areas above Flood Pool:											
Forest	0	92	102	9.1	928						
Crop	0	123	137	7.3	1,000						
Brome	0	14	16	4.6	74						
Prairie	0	454	505	6.8	3,434						
Total		683	760								
Above Flood Pool to Take line (except Rec. Area):											
Forest	0	193	215	9.1	1,957						
Crop	0	261	290	7.3	2,117						
Brome	0	30	33	4.6	152						
Prairie	0	965	1,072	6.8	7,290						
Total		1,449	1,610								
			21,412								

* Taken from Form # 3
** Applys only to terrestrial evaluation

FIGURE 9 (Continued). Terrestrial Habitat Evaluation (Form #4), Acreage Adjustment and Calculation of Total Habitat Unit Values

Form # 4

ALTERNATIVE PLAN EVALUATION BY PLANNING SEGMENT

Planning Area Onaga Dam & Res., Kansas
Alternative Plan A - NED plan
Sheet 1 of 1

Date 4/12/74
Summarized by Joint Committee
Terrestrial ☐
Aquatic ☒

Habitat Component by Planning Segment	Year	Acreage		Existing		% Habitat Units lost or gained per Acre	Habitat Units lost or gained per Acre (-or+)	Total Habitat Units lost or gained (-or+)	**Project Credits from private to public land ownership.		Total Net Habitat U lost or gained (- or +)
		From Form # 3 (Terr only)	Adjusted terrestrial and actual aquatic acreage	*Value per Acre	Total Habitat Unit Value				credits in unit per acre	adjusted habitat units lost or gained per acre	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	)	(10)
Below Dam:											
Channelized	0		14.2	6.2	88.0						
Conservation Pool:											
Unchannelized	0		36.4	5.7	207.5						
Tributaries	0		9.4	5.4	50.8						
Reservoir	0		5,320.0	—	—						
Flood Pool:											
Unchannelized	0		28.4	5.7	161.8						
Tributaries	0		18.1	5.4	97.7						
Farm Pond	0		1.0	5.0	5.0						
Above Flood Pool:											
Tributaries	0		108.7	5.4	587.0						

* Taken from Form # 3
** Applys only to terrestrial evaluation

FIGURE 10. Aquatic Habitat Evaluation (Form #4): Calculation of Total Habitat Unit Values by Planning Segments

209

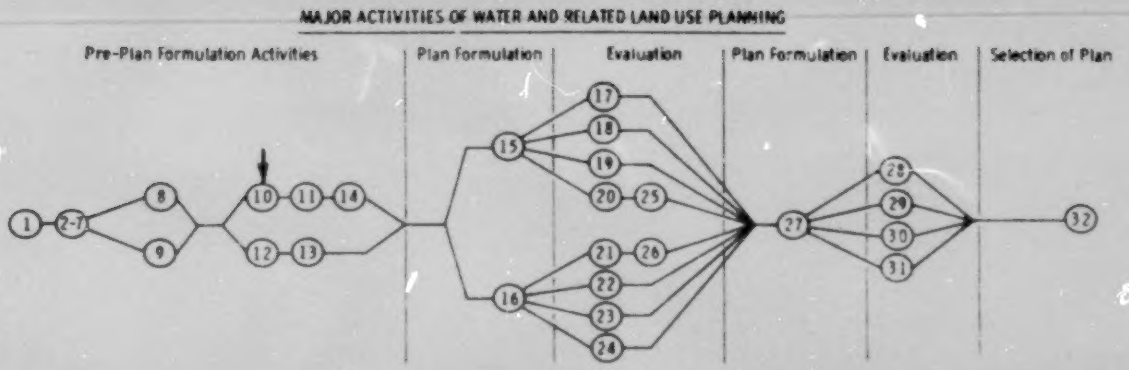
- Channelized Creek
- Unchannelized Creek
- Tributaries
- Farm Ponds
- Reservoirs

Activity 10 (Figure 11) of the Pre-Plan Formulation Activities is the determination of the status of future ecological resources without consideration of any plans for the area under study over the period of analysis. This case example is unique because no change in land use or human activities without a project are projected over the period of analysis, and only one (1) change is projected to occur in the ecosystem dynamics. As indicated in Figure 12, the channelized portion of Vermillion Creek fully recovers to a natural state by target year 50. This assumption is based on the prediction that no maintenance work would be conducted and the stream, by natural processes, would cut a meandering channel creating typical pools and riffles. The existing status of the total ecosystem dynamics should be narratively documented--such as the seral stages of plant community succession and aquatic ecosystem tropic levels and so forth. Also, notes should be taken of any species occurring in or affected in the planning area which would be considered threatened or in danger of extinction.

As indicated in Figure 13, Activity 11 is the specification of the component needs of Environmental Quality Objective in the planning area. Note, however, that this activity is not treated in this presentation but is stated only to give some perspective to the sequence of the planning process. Activity 14 (last activity in the Pre-Plan formulation stage) is an Environmental Quality Planning aid report to anyone involved in the planning process. The report summarizes the EQ without plan analysis of the planning area.

Activities 15, 16 and 27 (Figure 14) are actual plan formulation exercises.

Figure 15, Activities 19, 17 and 28 are the measurement of effects of an alternative plan on Environmental Quality. In other words, it is the EQ evaluation account. The development and display of the EQ evaluation account for each alternative plan developed is a mandatory requirement of the Principles and Standards.



1. Review Level A and B projections and requirements for planning area.
2. Review of documented physical land resources (soil stability and geological resources) in planning area.
3. Review documented air and water quality in planning area.
4. Review documented ecological resources in planning area.
5. Review documented culturally significant resources in planning area.
6. Review other NED planning in area.
7. Review RD and SWB planning by other entities.
8. Existing without plans inventory and evaluation of EQ components in planning area.
9. Set economic and population and land use projections in planning area.
10. Future without plans evaluation of EQ components.
11. Specify component needs of Environmental Quality Objective for the planning area.
12. Evaluate NED resource capabilities without any plans.
13. Specify component needs of the NED objective for planning area.
14. EQ planning aid report to NED formulation subteam.
15. EQ plan formulation.
16. NED plan formulation.
17. EQ Plan--NED evaluation account.
18. EQ Plan--RD evaluation account.
19. EQ Plan--SWB evaluation account.
20. EQ Plan--EQ evaluation account.
21. NED Plan--EQ evaluation account.
22. NED Plan--NED evaluation account.
23. NED Plan--RD evaluation account.
24. NED plan--SWB evaluation account.
25. Compensation needs--for EQ Plan.
26. Compensation needs--for NED Plan.
27. MOP(s) formulation.
28. MOP--EQ evaluation account.
29. MOP--NED evaluation account.
30. MOP--RD evaluation account.
31. MOP--SWB evaluation account.
32. Selection of Recommended Plan.

FIGURE 11. Future Terrestrial EQ Component Evaluation Without Any Plans (Activity #10)

Form # 4

ALTERNATIVE PLAN EVALUATION BY PLANNING SEGMENT

Planning Area ONAGA DAM & RES, KANSAS
Alternative Plan A-NED
Sheet 1 OF 1

Date 12-4-74
Summarized by JOINT COMMITTEE
Terrestrial ☐
Aquatic ☒

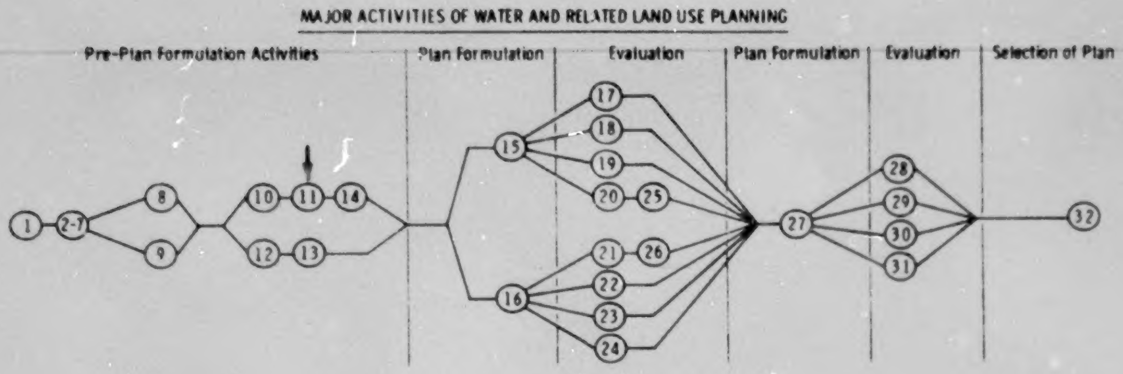
Habitat Components by Planning Segment	Year	Acreage: From Form # 3 (Terr only)	Acreage: Adjusted terrestrial and actual aquatic acreage	Existing: *Value per Acre	Existing: Total Habitat Unit Value	% Habitat Units lost or gained per Acre	Habitat Units lost or gained per Acre (-or+)	Annual Habitat Units lost or gained (-or+)	**Project Credits from private to public land ownership: credits in unit per acre	**Project Credits from private to public land ownership: adjusted habitat units lost or gained per acre	Annual Net Habitat Units lost or gained (- or +)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
BELOW DAM											
CHANNELIZED	0		14.2	6.2	88.0						
"	25		14.2	6.7	95.1						
"	[illegible]		14.2	7.2	102.2						
UNCHANNELIZED	50 ⊗										
"	0		3.1	5.7	17.7						
CONSERVATION POOL											
UNCHANNELIZED	0		36.4	5.7	207.5						
TRIBUTARIES	0		9.4	5.4	50.8						
RESERVOIR	0		5,320.0	—	—						
FLOOD POOL											
UNCHANNELIZED	0		28.4	5.7	1618						
TRIBUTARIES	0		18.1	5.4	97.7						
FARM PONDS	0		1.0	5.0	5.0						
ABOVE FLOOD POOL											
TRIBUTARIES	0		108.7	5.4	587.0						

⊗ AFTER YEAR 50, THE CHANNELIZED SEGMENT WAS CONSIDERED UNCHANNELIZED.

EXAMPLE OF
CHANNELIZED
CREEK REVERTING
OVER TIME BACK
TO NATURAL
STATE.

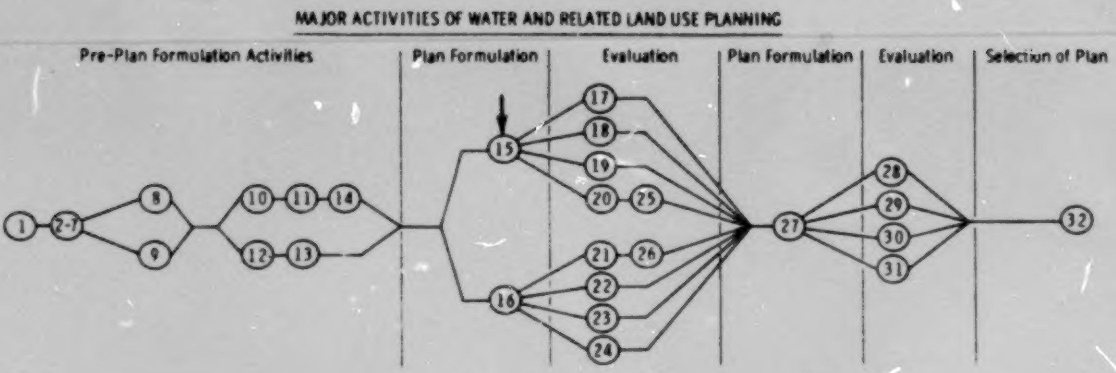
* Taken from Form # 3
** Applies only to terrestrial evaluation

FIGURE 12. Example of the Future Without Any Coordinated Plan Analysis of the Aquatic Ecosystem



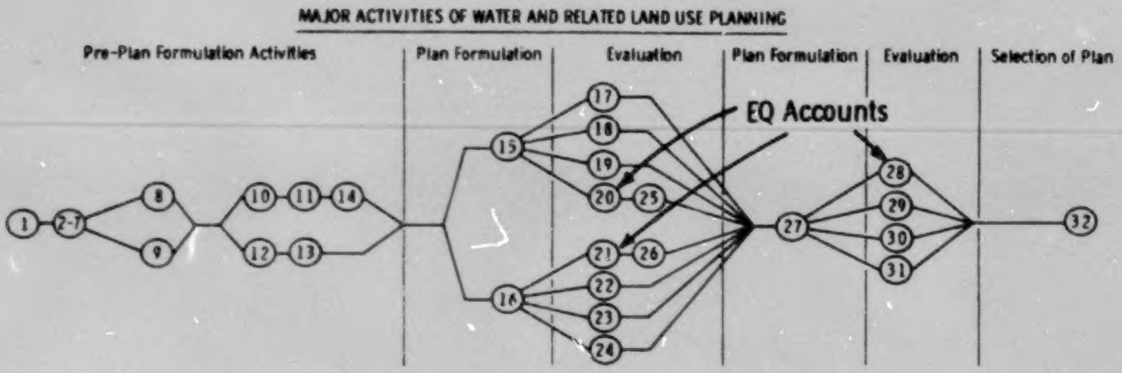
1. Review Level A and B projections and requirements for planning area.
2. Review of documented physical land resources (soil stability and geological resources) in planning area.
3. Review documented air and water quality in planning area.
4. Review documented ecological resources in planning area.
5. Review documented culturally significant resources in planning area.
6. Review other NED planning in area.
7. Review RD and SWB planning by other entities.
8. Existing without plans inventory and evaluation of EQ components in planning area.
9. Set economic and population and land use projections in planning area.
10. Future without plans evaluation of EQ components.
11. Specify component needs of Environmental Quality Objective for the planning area.
12. Evaluate NED resource capabilities without any plans.
13. Specify component needs of the NED objective for planning area.
14. EQ planning aid report to NED formulation subteam.
15. EQ plan formulation.
16. NED plan formulation.
17. EQ Plan--NED evaluation account.
18. EQ Plan--RD evaluation account.
19. EQ Plan--SWB evaluation account.
20. EQ Plan--EQ evaluation account.
21. NED Plan--EQ evaluation account.
22. NED Plan--NED evaluation account.
23. NED Plan--RD evaluation account.
24. NED plan--SWB evaluation account.
25. Compensation needs--for EQ Plan.
26. Compensation needs--for NED Plan.
27. MOP(s) formulation.
28. MOP--EQ evaluation account.
29. MOP--NED evaluation account.
30. MOP--RD evaluation account.
31. MOP--SWB evaluation account.
32. Selection of Recommended Plan.

FIGURE 13. Specification of Component Needs of Terrestrial EQ Objective (Activity #11)



1. Review Level A and B projections and requirements for planning area.
2. Review of documented physical land resources (soil stability and geological resources) in planning area.
3. Review documented air and water quality in planning area.
4. Review documented ecological resources in planning area.
5. Review documented culturally significant resources in planning area.
6. Review other NED planning in area.
7. Review RD and SWB planning by other entities.
8. Existing without plans inventory and evaluation of EQ components in planning area.
9. Set economic and population and land use projections in planning area.
10. Future without plans evaluation of EQ components.
11. Specify component needs of Environmental Quality Objective for the planning area.
12. Evaluate NED resource capabilities without any plans.
13. Specify component needs of the NED objective for planning area.
14. EQ planning aid report to NED formulation subteam.
15. EQ plan formulation.
16. NED plan formulation.
17. EQ Plan--NED evaluation account.
18. EQ Plan--RD evaluation account.
19. EQ Plan--SWB evaluation account.
20. EQ Plan--EQ evaluation account.
21. NED Plan--EQ evaluation account.
22. NED Plan--NED evaluation account.
23. NED Plan--RD evaluation account.
24. NED plan--SWB evaluation account.
25. Compensation needs--for EQ Plan.
26. Compensation needs--for NED Plan.
27. MOP(s) formulation.
28. MOP--EQ evaluation account.
29. MOP--NED evaluation account.
30. MOP--RD evaluation account.
31. MOP--SWB evaluation account.
32. Selection of Recommended Plan.

FIGURE 14. Terrestrial EQ Plan Formulation (Activity #15)



1. Review Level A and B projections and requirements for planning area.
2. Review of documented physical land resources (soil stability and geological resources) in planning area.
3. Review documented air and water quality in planning area.
4. Review documented ecological resources in planning area.
5. Review documented culturally significant resources in planning area.
6. Review other NED planning in area.
7. Review RD and SWB planning by other entities.
8. Existing without plans inventory and evaluation of EQ components in planning area.
9. Set economic and population and land use projections in planning area.
10. Future without plans evaluation of EQ components.
11. Specify component needs of Environmental Quality Objective for the planning area.
12. Evaluate NED resource capabilities without any plans.
13. Specify component needs of the NED objective for planning area.
14. EQ planning aid report to NED formulation subteam.
15. EQ plan formulation.
16. NED plan formulation.
17. EQ Plan--NED evaluation account.
18. EQ Plan--RD evaluation account.
19. EQ Plan--SWB evaluation account.
20. EQ Plan--EQ evaluation account.
21. NED Plan--EQ evaluation account.
22. NED Plan--NED evaluation account.
23. NED Plan--RD evaluation account.
24. NED plan--SWB evaluation account.
25. Compensation needs--for EQ Plan.
26. Compensation needs--for NED Plan.
27. MOP(s) formulation.
28. MOP--EQ evaluation account.
29. MOP--NED evaluation account.
30. MOP--RD evaluation account.
31. MOP--SWB evaluation account.
32. Selection of Recommended Plan.

FIGURE 15. Terrestrial EQ Evaluation Accounts for NED, EQ, and MO Plans (Activities #20, 21 and 28)

Coming back to Form 4, Figure 16, it is now essential to calculate for each alternative plan the habitat units (HU) lost or gained for each habitat component by planning segment and target year as follows:

With regard to the Conservation Pool planning segment, note that 100 percent of the terrestrial habitat unit value per acre is lost and the Forestlands component of plus 8 HU/acre in column (3) changes to a minus 8 HU/acre in column (6). The total HU lost is the product of the acreage in column (2) and the HU lost per acre in column (6). Column (8) is a "gift" which ranges on a scale from 0 to 1 for converting private lands into public ownership in fee title. In this example, the credit was 1 HU per acre, thus reducing the loss for the Forestlands component from -8 to -7. The total net habitat units lost or gained in column (10) is the product of the number of acres in column (2) and the adjusted habitat units lost in column (9). Thus, the total number of terrestrial habitat units lost in the Conservation Pool planning segment total equals -31,360 habitat units.

In the Flood Pool planning segment, a loss of 50 percent of the HU per acre is determined based on the effect of the five (5) to ten (10) year flood frequency on terrestrial habitat. The total habitat loss in the Flood Pool planning segment comes to -14,211 HU.

In the Above Flood Above Takeline planning segment, note that the effect on the lands above the Takeline takes place in target year 25. In this example, and estimated loss of ten (10) percent of the HU value within one (1) mile above the Takeline was attributed to housing development around the reservoir area.

The other planning segments evaluated are:

- Below Dam--Except Recreation Areas
- Recreation Areas Below Dam
- Recreation Areas Above the Dam
- Above Flood Pool to Takeline

Having completed the above, the next step is to calculate the total net and annualized terrestrial HU lossed or gained between the "with" and "without" plans analysis for each habitat component in the study area (Figure 17). First, add all the gains and losses for all planning segments for each habitat component.

Form # 4

ALTERNATIVE PLAN EVALUATION BY PLANNING SEGMENT

Planning Area Onaga Dam & Res., Kansas
Alternative Plan A - NED plan
Sheet 1 of 2

Date 4/10/74
Summarized by Joint Committee
Terrestrial ☒
Aquatic ☐

Habitat Component by Planning Segment	Year	Acreage		Existing		% Habitat Units lost or gained per Acre	Habitat Units lost or gained per Acre (-or+)	Total Habitat Units lost or gained (-or+)	**Project Credits from private to public land ownership.		Total Net Habitat Units lost or gained (- or +)
		From Form # 3 (Terr only)	Adjusted terrestrial and actual aquatic acreage	*Value per Acre	Total Habitat Unit Value				credits in unit per acre	adjusted habitat units lost or gained per acre	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Conservation Pool:											
Forest	0	1,144	1,273	8.0	10,184	- 100%	- 8.0	-10,184	+ 1	- 7.0	- 8,911
Crop	0	3,293	3,651	6.7	24,462	- 100%	- 6.7	-24,462	+ 1	- 5.7	- 20,811
Brome	0	250	277	4.2	1,163	- 100%	- 4.2	- 1,163	+ 1	- 3.2	- 886
Native Prairie	0	65	73	7.4	540	- 100%	- 7.4	- 540	+ 1	- 6.4	- 467
Rivers & Streams	0	46	46	7.2	331	- 100%	- 7.2	- 331	+ 1	- 6.2	- 285
Total		4,798	5,320					-36,680			- 31,360
Flood Pool:											
Forest	0	1,239	1,405	9.1	12,786	- 50%	- 4.5	- 6,322	+ 1	- 3.5	- 4,918
Crop	0	2,429	2,743	7.2	19,750	- 50%	- 3.6	- 9,875	+ 1	- 2.6	- 7,132
Brome	0	614	693	4.5	3,119	- 50%	- 2.3	- 1,594	+ 1	- 1.3	- 901
Prairie	0	348	393	7.7	3,026	- 50%	- 3.9	- 1,533	+ 1	- 2.9	- 1,140
Streams	0	46	46	7.2	331	- 50%	- 3.6	- 166	+ 1	- 2.6	- 120
Total		4,676	5,280					-19,490			- 14,211
Above Flood Above takeline: ⊛											
Forest	25	835	929	9.1	8,454	- 10%	- 0.9	- 836	0	- 0.9	- 836
Crop	25	148	164	7.3	1,197	- 10%	- 0.7	- 115	0	- 0.7	- 115
Brome	25	133	148	4.6	681	- 10%	- 0.5	- 74	0	- 0.5	- 74
Prairie	25	5,218	5,798	6.8	39,423	- 10%	- 0.7	- 4,059	0	- 0.7	- 4,059
Streams	25	8	8	7.2	58	- 10%	- 0.7	- 6	0	- 0.7	- 6
Total		6,342	7,047					- 5,090			- 5,090
Below Dam (except Rec. Areas)											
Forest	0	233	259	7.9	2,046	0	0	0	0	0	0
Crop	0	477	532	7.2	3,830	0	0	0	0	0	0
Prairie	0	209	232	7.5	1,740	0	0	0	0	0	0
Streams	0	17	17	7.2	122	0	0	0	0	0	0
Total		936	1,040								0

⊛ the initial effect is zero; This analysis displays the 25th year effect.

* Taken from Form # 3
** Applys only to terrestrial evaluation

FIGURE 16. Terrestrial Habitat Evaluation (Form #4), Net Habitat Units Lost or Gained by Habitat Component and Planning Segment for Each Plan

Form # 4

ALTERNATIVE PLAN EVALUATION BY PLANNING SEGMENT

Planning Area Onaga Dam & Res., Kansas
Alternative Plan A - NED
Sheet 2 of 2

Date 4/10/74
Summarized by Joint Committee
Terrestrial [X]
Aquatic [ ]

Habitat Component by Planning Segment	Year	Acreage		Existing		% Habitat Units lost or gained per Acre	Habitat Units lost or gained per Acre (-or+)	Total Habitat Units lost or gained (-or+)	**Project Credits from private to public land ownership.		Total Net Habitat Units lost or gained (- or +)
		From Form # 3 (Terr only)	Adjusted terrestrial and actual aquatic acreage	*Value per Acre	Total Habitat Unit Value				credits in unit per acre	adjusted habitat units lost or gained per acre	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rec. Area below Dam:											
Forest	0	93	94	7.9	743	- 75%	- 5.9	- 555	+ 1	- 4.9	- 461
Crop	0	167	183	7.2	1,318	- 75%	- 5.4	- 988	+ 1	- 4.4	- 805
Prairie	0	70	78	7.5	585	- 75%	- 5.6	- 437	+ 1	- 4.6	- 359
Total		320	355					-1,980			-1,625
Rec. Areas above Flood Pool:											
Forest	0	92	102	9.1	928	- 75%	- 6.8	- 694	+1	- 5.8	- 592
Crop	0	123	137	7.3	1,000	- 75%	- 5.5	- 754	+1	- 4.5	- 617
Brome	0	14	16	4.6	74	- 75%	- 3.5	- 56	+1	- 2.5	- 40
Prairie	0	454	505	6.8	3,434	- 75%	- 5.1	-2,576	+1	- 4.1	-2,071
Total		683	760					- 4,080			- 3,320
Above Flood Pool to Take line (except Rec. Area):											
Forest	0	193	215	9.1	1,957	0	0	0	+1	+ 1.0	+ 215
Crop	0	261	290	7.3	2,117	0	0	0	+1	+ 1.0	+ 290
Brome	0	30	33	4.6	152	0	0	0	+1	+ 1.0	+ 33
Prairie	0	965	1,072	6.8	7,290	0	0	0	+1	+ 1.0	+1,072
Total		1,449	1,610					0			+1,610
			21,412								

* Taken from Form # 3
** Applys only to terrestrial evaluation

FIGURE 16 (Continued). Terrestrial Habitat Formulation (Form #4), Net Habitat Units Lost or Gained by Habitat Component and Planning Segment for Each Plan

For example, under the Forestland component the HU losses by planning segment are:

Conservation Pool.	- 8,911 HU
Flood Pool	- 4;918 HU
Recreation Area Below Dam. . . .	- 461 HU
Recreation Area Above Dam. . . .	- 592 HU
Above Flood Pool to Takeline . .	+ 215 HU
	-14,667 HU

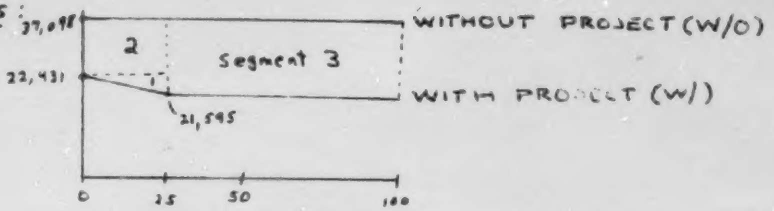
The algebraic sum of these losses and gains represents the initial effect of the alternative plan, which in this case is a National Economic Development (NED) plan for the Forestland component of the Terrestrial Ecosystem. The loss in this example, as indicated above, is -14,667 Forestland HU during the initial year of the plan. However, note that an additional loss of -836 Forestland habitat units occurred from housing development within one mile outside the project takeline in target year 25. The effect on the Forestland habitat units is represented by the area between the "with" (w/) and "without" (w/o) projections of HU over the period of analysis. This area is calculated in terms of habitat units by segment calculations as illustrated in Figure 17. For example, the area of segment 1, a 90° triangle is simply length x width divided by 2, while the areas of segments 2 and 3 are the products of length x width for each rectangle. The algebraic sum of these segment areas represent a total net loss in Forestland habitat units of -1,539,850 (HU). The average annual loss over a period of 100 years is then -15,399 HU (habitat units).

The above series of calculations are then completed for the other habitat components in the planning area with the following results:

		Total HU Net Loss	Annualized HU Effect
Croplands	-	-2,917,563	-29,176
Brome Pastures	-	- 185,875	- 1,859
Native Pastures	-	- 651,663	- 6,517
Rivers and Streams	-	- 41,025	- 410

With regard to the above classification "Rivers and Streams", the question may arise as to why this classification should be included in the Terrestrial Ecosystem? It is included, because by definition of this ecosytem evaluation procedures includes values contributing to furbearers, waterfowl, marsh and shore birds, amphibians, and so forth.

Forestlands:



− 8,911
− 4,918
− 461
− 592

− 14,882
+ 215

− 14,667 − initial impact
− 836

− 15,503 − 25th year

Seg. 1 $-\frac{836 \times 25}{2} =$ − 10,450

Seg. 2 − 14,667 x 25 = − 336,675

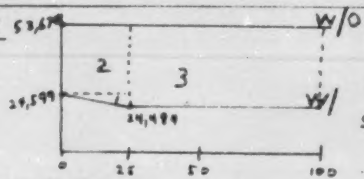
Seg. 3 − 15,503 x 75 = − 1,162,725

− 1,539,850

$$100 \overline{\big)\, -1{,}539{,}850} = -15{,}399$$

− 15,399 ← annualized effect in habitat units

Croplands



− 20,811
− 7,132
− 805
− 617

− 29,365
+ 290

− 29,075 − initial impact
− 115

− 29,190 − 25th year

Seg. 1 $-\frac{115 \times 25}{2} =$ − 1,438

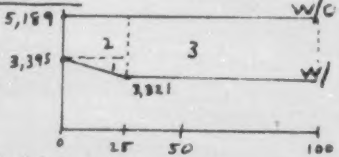
Seg. 2 − 29,075 x 25 = − 726,875

Seg. 3 − 29,190 x 75 = − 2,189,250

100 ⌊ − 2,917,563

Annualized effect = − 29,176

Brome Pasture



− 886
− 901
− 40

− 1,827
+ 33

− 1,794 − initial impact
− 74

− 1,868 − 25th year

Seg. 1 $-\frac{74 \times 25}{2} =$ − 925

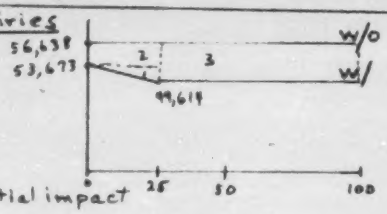
Seg. 2 − 1,794 x 25 = − 44,850

Seg. 3 − 1,868 x 75 = − 140,100

100 ⌊ − 185,875

Annualized effect = − 1,859

Native Prairies



− 467
− 1,140
− 359
− 2,071

− 4,037
+ 1,072

− 2,965 − initial impact
− 4,059

− 7,024 − 25th year

Seg. 1 $-\frac{4{,}059 \times 25}{2} =$ − 50,738

Seg. 2 − 2,965 x 25 = − 74,125

Seg. 3 − 7,024 x 75 = − 526,800

100 ⌊ − 651,663

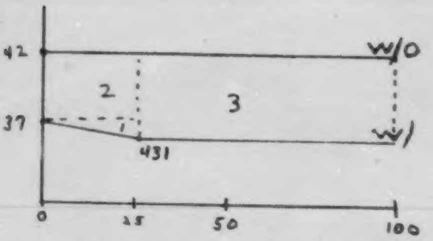
Annualized effect = − 6,517

Rivers & Streams on next page.

FIGURE 17. Calculation of Total Net and Annualized Terrestrial Habitat Units Lost or Gained

Rivers and STreams

- 285
- 120
- 405 ...initial impact
- 6
- 411 - 25th year



Seg.1 $\frac{-6 \times 25}{2} =$ − 75

Seg.2 −405 x 25 = − 10,125

Seg.3 −411 x 75 = − 30,825

$100 \overline{)\,-41,025}$

$\underline{\underline{-410}}$ = annualized effect

FIGURE 17 (Continued). Calculation of Total Net and Annualized Terrestrial Habitat Units Lost or Gained

Form 5, Figure 18 provides for a display of effects by target year on a comparative basis between the w/ and w/o plan conditions for all plans. Note that the accumulative net change by target years, the annualized value, and the with and without analysis of effects were transferred from Figure 17 to Figure 18, Form 5. For example, note that under the Forestlands habitat component, the initial year loss effect was -14,667 HU which algebraically added to +37,098 HU of Forestlands equals +22,431 habitat units remaining in year zero. The loss of an additional -836 HU in target year 25 further reduces the Forestland habitat units to +21,595 resulting in an overall net loss of -1,539,850 or an average annual loss of -15,399 HU. Similar data is transferred to Form 5 in the same manner for each of the other habitat components of a given alternative plan under evaluation. In addition, the terrestrial ecosystem evaluations are also computed for Plan B, Plan C and Plan D.

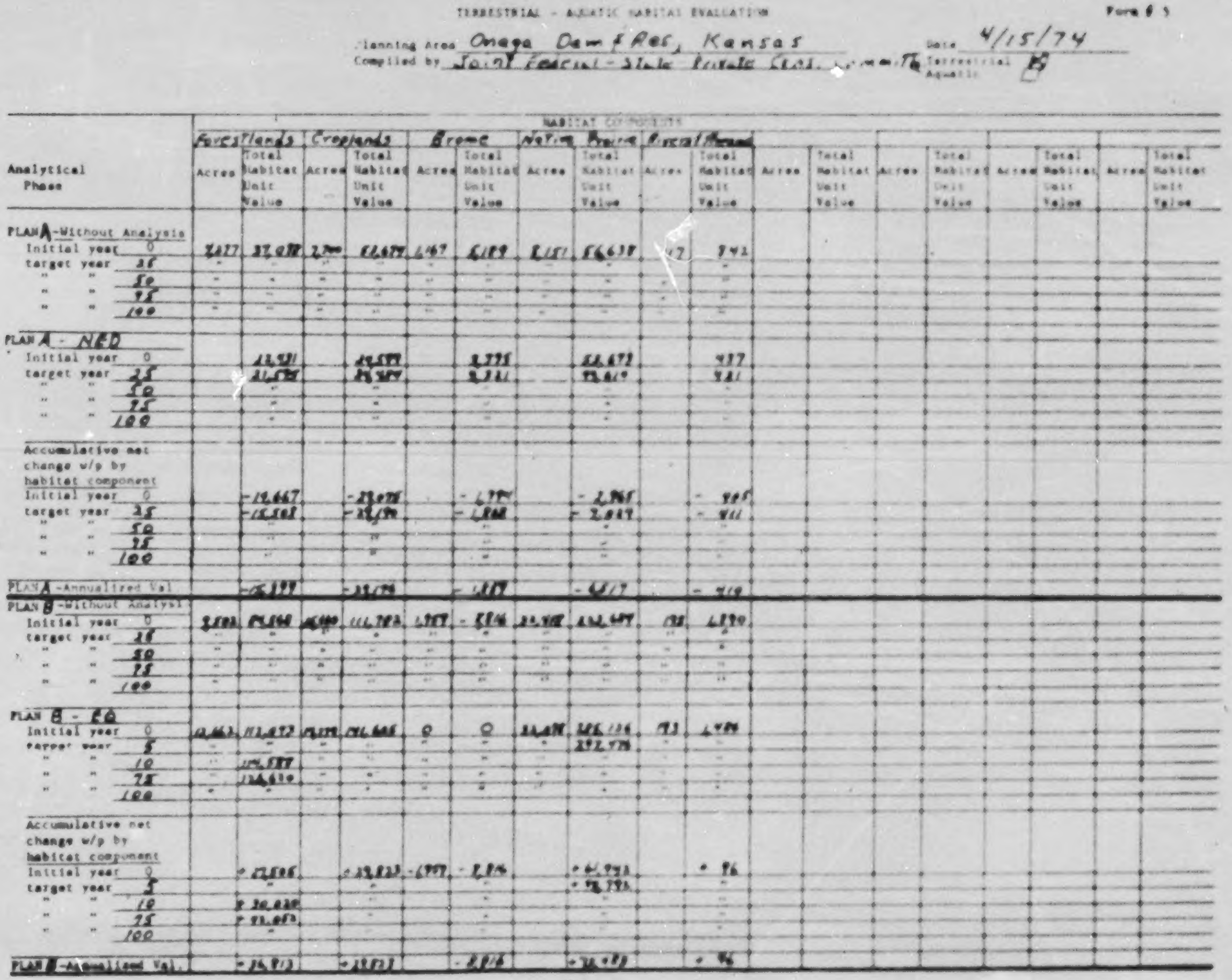
Form 6, Figure 19 is a Habitat Unit Summary Comparison Table. The total net HU losses and annualized values are transferred from Form 5 to Form 6 and thus in a single table are displayed the effects of each alternative plan on the terrestrial ecosystem. Summarizing in terms of HU lost or gained by each plan is as follows:

- Plan A which is an NED plan shows a total loss of -5,335,976 HU.
- Plan B, an optimized EQ plan with almost triple the planning area, indicates a total gain of +13,139,890 HU.
- Plan C, which is still an EQ plan but is restricted to the same acreage as the NED and MOP plans for comparative purposes, indicates a total gain of +3,657,325 HU.
- Plan D or the Multiple Objective Plan (MOP) shows a total loss of -3,977,250 HU.

This whole process described above for the terrestrial ecosystem is repeated for the Aquatic Ecosystem. Form 6, Figure 20 is a Habitat Unit Summary Comparison Table for the Aquatic Ecosystem. Note the gain in habitat units for the reservoir habitat type while a loss occurs in the creek and tributary habitat-types in Plans A and B.

2. Description of Ecosystem Relationships and Effects on Endangered Species

In addition to the habitat unit evaluation of the Terrestrial and Aquatic Ecosystems, a narrative description should be recorded on the expected effects of each plan on ecosystem relationships including irreversible



TERRESTRIAL - AQUATIC HABITAT EVALUATION

Form # 5

Planning Area Onaga Dam & Res, Kansas
Date 4/15/74
Compiled by Joint Federal-State Private Cons. Committee
Terrestrial ☒
Aquatic ☐

Analytical Phase	Forestlands Acres	Forestlands Total Habitat Unit Value	Croplands Acres	Croplands Total Habitat Unit Value	Brome Acres	Brome Total Habitat Unit Value	Native Prairie Acres	Native Prairie Total Habitat Unit Value	Riverine/[illegible] Acres	Riverine/[illegible] Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value
PLAN A-Without Analysis																		
Initial year 0	2,277	37,078	2,700	62,674	1,467	6,189	8,151	56,638	17	742								
target year 25	"	"	"	"	"	"	"	"	"	"								
" " 50	"	"	"	"	"	"	"	"	"	"								
" " 75	"	"	"	"	"	"	"	"	"	"								
" " 100	"	"	"	"	"	"	"	"	"	"								
PLAN A - NED																		
Initial year 0		12,421		24,599		2,775		53,673		437								
target year 25		21,578		26,404		2,311		53,619		331								
" " 50		"		"		"		"		"								
" " 75		"		"		"		"		"								
" " 100		"		"		"		"		"								
Accumulative net change w/p by habitat component																		
Initial year 0		-12,667		-23,075		-1,994		-2,965		-305								
target year 25		-15,508		-35,184		-1,868		-2,019		-411								
" " 50		"		"		"		"		"								
" " 75		"		"		"		"		"								
" " 100		"		"		"		"		"								
PLAN A -Annualized Val		-15,199		-33,174		-1,817		-4,417		-410								
PLAN B -Without Analysis																		
Initial year 0	2,583	89,568	16,400	111,782	1,957	-5,816	20,412	252,657	175	1,890								
target year 25	"	"	"	"	"	"	"	"	"	"								
" " 50	"	"	"	"	"	"	"	"	"	"								
" " 75	"	"	"	"	"	"	"	"	"	"								
" " 100	"	"	"	"	"	"	"	"	"	"								
PLAN B - EQ																		
Initial year 0	12,663	113,472	19,579	141,606	0	0	23,609	326,136	193	1,486								
target year 5	"	"	"	"	"	"	"	292,779	"	"								
" " 10	"	125,587	"	"	"	"	"	"	"	"								
" " 25	"	136,610	"	"	"	"	"	"	"	"								
" " 100	"	"	"	"	"	"	"	"	"	"								
Accumulative net change w/p by habitat component																		
Initial year 0		+23,506		+29,823	-1,957	-5,816		+61,931		+96								
target year 5		"		"		"		+78,773		"								
" " 10		+30,830		"		"		"		"								
" " 25		+41,052		"		"		"		"								
" " 100		"		"		"		"		"								
PLAN B -Annualized Val.		+26,913		+29,823		-5,816		+72,483		+96								

FIGURE 18. Terrestrial Habitat Evaluation (Form #5), Summary of Total Net and Annualized Habitat Units Lost or Gained by Habitat Component for All Plans

TERRESTRIAL - AQUATIC HABITAT EVALUATION

Form # 5

Planning Area Onaga Dam & Res., Kansas

Compiled by Joint Federal-State-Private Cons. Committee

Date 4/15/74

Terrestrial ☒

Aquatic ☐

Analytical Phase	HABITAT COMPONENTS																	
	Forestlands		Croplands		Brome		Native Prairie		Rivers & Streams									
	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value	Acres	Total Habitat Unit Value
PLAN C-Without Analysis																		
Initial year 0	9,277	38,065	7,400	54,670	1,167	5,252	8,151	56,242	117	842								
target year 25	"	"	"	"	"	"	"	"	"	"								
" " 50	"	"	"	"	"	"	"	"	"	"								
" " 75	"	"	"	"	"	"	"	"	"	"								
" " 100	"	"	"	"	"	"	"	"	"	"								
PLAN C-reduced EQ																		
Initial year 0	9,277	40,631	6,519	68,573	0	0	10,199	73,359	117	901								
target year 5	"	"	"	"	"	"	"	81,749	"	"								
" " 25	"	"	"	"	"	"	"	"	"	"								
" " 50	"	"	"	"	"	"	"	"	"	"								
" " 100	"	"	"	"	"	"	"	"	"	"								
Accumulative net change w/p by habitat component																		
Initial year 0		+ 2,566	- 881	+ 13,903	-1,167	- 5,252	+2,048	+ 17,117		+ 59								
target year 5		"		"		"		+ 25,507		"								
" " 25		"		"		"		"		"								
" " 50		"		"		"		"		"								
" " 100		"		"		"		"		"								
PLAN C-Annualized Val.		+ 2,566		+ 13,903		- 5,252		+ 25,299		+ 59								
PLAN D-Without Analysis																		
Initial year 0	9,096	35,450	7,313	58,908	441	1,918	9,455	65,333	107	770								
target year 25	"	"	"	"	"	"	"	"	"	"								
" " 50	"	"	"	"	"	"	"	"	"	"								
" " 75	"	"	"	"	"	"	"	"	"	"								
" " 100	"	"	"	"	"	"	"	"	"	"								
PLAN D- MOF																		
Initial year 0		22,024		29,718		992		70,936		385								
target year 25		21,188		29,603		918		66,877		"								
" " 50		"		"		"		"		"								
" " 75		"		"		"		"		"								
" " 100		"		"		"		"		"								
Accumulative net change w/p by habitat component																		
Initial year 0		- 13,426		- 29,190		- 926		+ 5,603		- 385								
target year 25		- 14,262		- 29,305		-1,000		+ 1,544		"								
" " 50		"		"		"		"		"								
" " 75		"		"		"		"		"								
" " 100		"		"		"		"		"								
PLAN D-Annualized Val.		-14,158		-29,291		- 991		+ 2,051		- 385								

FIGURE 18 (Continued). Terrestrial Habitat Evaluation (Form #5), Summary of Total Net and Annualized Habitat Units Lost or Gained by Habitat Component for All Plans

Form # 6.

HABITAT UNIT SUMMARY COMPARISON TABLE

Planning Area: Onaga Dam & Reservoir, Kansas

Date: 4/19/74

Summarized by: Joint Committee

Terrestrial ☒

Aquatic ☐

Habitat Component by Alternative Plans	Effect of Plan Acreage (1)	 Net Habitat Unit Loss or Gain (1a)	 Annualized Habitat Unit Loss or Gain (2)
Alternative Plan A - NED			
Forestland	4,277	-1,539,850	-15,399
Cropland	7,700	-2,917,563	-29,176
Brome Pasture	1,167	-185,875	-1,859
Native Prairie	8,151	-691,663	-6,917
Rivers & Streams	117	-41,026	-410
**Total	21,412	-5,335,976	-53,361
Alternative Plan B - EQ			
Forestland	12,662	+3,681,265	+36,813
Cropland	14,779	+2,982,300	+29,823
Brome Pasture	0	-881,600	-8,816
Native Prairie	32,098	+7,348,325	+73,483
Rivers & Streams	193	+9,600	+96
**Total	59,732	+13,139,890	+131,399
Alternative Plan C - EQ (reduced)			
Forestland	4,277	+256,600	+2,566
Cropland	6,819	+1,390,300	+13,903
Brome Pasture	0	-528,200	-5,282
Native Prairie	10,199	+2,529,325	+25,293
Rivers & Streams	117	+5,900	+59
**Total	21,412	+3,657,325	+36,573
Alternative Plan D - MOP			
Forestland	4,096	-1,415,750	-14,158
Cropland	7,313	-2,629,065	-26,291
Brome Pasture	441	-94,075	-941
Native Prairie	9,455	+208,138	+2,081
Rivers & Streams	107	-38,500	-385
**Total	21,412	-3,972,250	-39,774

**The component habitat unit values are only additive for the calculation of mitigation needs when one of the following conditions exist: (1) An exception to the General Policy of mitigation in-kind or (2) The frequency distribution of habitat components in the lands proposed for mitigation purposes are comparable to those in the project area where the losses occurred.

FIGURE 19. Habitat Unit Summary Comparison Table Displaying the Effects of Alternative Plans on Terrestrial Ecosystems

Figure # 6.

HABITAT UNIT SUMMARY COMPARISON TABLE

Planning Area: Onaga Dam & Reservoir, Kansas

Date: 4/19/74

Summarized by: Joint Committee

Terrestrial ☐

Aquatic ☒

Habitat Component by Alternative Plans	Effect of Plan		
	Acreage (1)	Net Habitat Unit Loss or Gain (1a)	Annualized Habitat Unit Loss or Gain (2)
Alternative Plan A-NED			
Channelized	14.2	+710.0	+14.2
Unchannelized	67.9	-26,240	-262.4
Tributaries	136.2	- 8,880	- 88.8
Reservoir	8,320	+2,061,600	+20,616.0
Farm Pond	1.0	- 100	- 1.0
Total *	219.3		
Alternative Plan B - EQ			
Channelized	14.2	+425.0	+8.5
Unchannelized	67.9	+4,495	+44.9
Tributaries	136.2	+6,810	+68.1
Farm Ponds	127.0	+6,350	+63.5
**Total	345.3		
Alternative Plan C - EQ (reduced)			
Channelized	14.2	+425	+8.5
Unchannelized	67.9	+4,495	+44.9
Tributaries	136.2	+6,810	+68.1
Farm Ponds	1.0	+ 50	+ 0.5
**Total	219.3		
Alternative Plan D-MOP			
Channelized	14.2	+710	+14.2
Unchannelized	67.9	-20,780	-207.8
Tributaries	136.2	+1,120	+ 11.2
Reservoirs	8,320	+2,516,870	+25,169.0
Farm Pond	1.0	- 100	- 1.0
Total *	219.3		

**The component habitat unit values are only additive for the calculation of mitigation needs when one of the following conditions exist: (1) An exception to the General Policy of mitigation in-kind or (2) The frequency distribution of habitat components in the lands proposed for mitigation purposes are comparable to those in the project area where the losses occurred.

***Does not include reservoir acreage.

FIGURE 20. Habitat Unit Summary Comparison Table Displaying the Effects of Alternative Plans on Aquatic Ecosystems

commitments of ecological resources as well as the expected effects of each plan on plants or animals endangered or threatened with extinction.

D. Culturally Significant Resources

1. The Principles and Standards (p. 34) define archeological and historical resources as the:

   > "Management, preservation, or enhancement of especially valuable or outstanding archeological, historical . . . resources . . .".

A rigorous w/ and w/o plan analysis requirement of the P&S will apply in detail to the EQ components and evaluation parameters of the Archeological and Historical Resources developed by the National Park Service as follows:

Since few areas of the Nation have been adequately surveyed for historical and/or archeological resources, simple consultation of lists of currently identified resources seldom will constitute sufficient investigation of the affected environment. Nonetheless, such lists of known resources should be the starting point for any assessment of effects. These lists include: (a) the National Register; (b) those nominated to or determined eligible for inclusion in the National Register, including those properties under Federal jurisdiction or control that must be nominated to the National Register pursuant to Section 2(a) of Executive Order 11593; and (c) other properties of historical and/or archeological significance, including those identified by appropriate State and local officials. Explanation and documentation should be provided in each case for those cultural resources professionally determined not to meet the National Register Criteria.

Early contact should be established with the Office of the State Historic Preservation Officer and reference should be made to the latest draft of the State Plan for Historic Preservation.

An archeological reconnaissance may be necessary to determine the existence and extent of surface of sub-surface resources. Field surveys and documentary research by historians, including architectural historians, may also be necessary to identify and evaluate certain other cultural resources. If any such resources are discovered, this reconnaissance survey should be followed by a more intensive examination to identify categories present and to evaluate their significance. There is an extensive range of possibilities of such historical values and data categories. For example, structures may embrace particular historical architecture or construction styles and techniques which should be identified; a structure or place may have associative values; and an archeological site may contain deeply stratified refuse, certain types of food remains, characteristic artifact assemblages, etc., which also should be identified.

Consultation with State, local, or university historians, archeologists, and/or architectural historians, with professional or regional organizations; with government agencies exercising program responsibilities or possessing special competence related to cultural resources; or with other individuals or groups informed about the cultural resources of a project area is usually necessary so that an accurate statement of resource significance may be given. An evaluation should also be made on the regional integration of the individually identified properties and values into a broader assessment of significance, and of interpretive and research potential.

With the above historical and archeological resource data for a given planning area, evaluation of the effect of any given alternative plan on identified properties should include careful consideration of the following: (a) adverse effects arising from destruction or alteration of all or part of a property, isolation from or alteration of its surrounding environment, or the introduction of physical, visual, audible, or atmospheric elements that are out of character with the property and its setting; (b) the cumulative impact of the proposed action upon the property, taken in consideration with impacts from other sources; (c) secondary or indirect impacts resulting from associated activities induced or promoted by the proposed action which may have a more substantial long-term impact on the property; (d) unavoidable adverse effects of the proposed action on the property, recognizing that this is an irreversible and irretrievable commitment and recognizing the unique and nonrenewable nature of such properties; and (e) the relationship between local short-term uses of the property and the long-term preservation and enhancement of the property, indicating to what extent long-term considerations of preservation and enhancement are foreclosed by the proposed action.

Adverse effects upon these resources may be cumulative. Progressive destruction of a characteristic category of cultural resources (for example, all archeological sites on a river floodplain, or all 17th century Dutch farmsteads) may seriously impair future opportunities for scientific research or preservation of our cultural heritage. Adverse secondary effects, from impacts on existing community facilities and activities, from new facilities and activities, or from changes of natural conditions, may often be more substantial than the primary or direct effects of the proposed action. For instance, will construction of a water control structure alter downstream flow patterns so that cultural resources situated beyond the project area will be destroyed by new or accelerated bank erosion?

Destruction or alteration of cultural resources, and consequent reduction of opportunities for future research or preservation, constitute an irreversible and irretrievable commitment.

Professional recommendations for mitigation should describe efforts that will be made to prevent or minimize loss of or intrusion upon cultural resources. Where destruction of such resources is unavoidable, the statement should explain intended measures to recover archeological and/or historical data. Such measures may include recording by photographs and measured drawings of cultural resources about to be lost or altered; archeological excavation to recover data and materials; removal of structures or salvage of historical architectural components; or other steps that will ensure full knowledge of the lost resources. The measures should ordinarily include provision for publication of information thus gained and initial deposition of artifacts and materials in a repository where they may be of public and educational benefit. There should be as many recommendations for minimizing impact as there are project alternatives which pose different situations. The foregoing identification, analysis of effects and recommendations for mitigation are required also for compliance with the "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800) prior to implementation of any mitigation actions.

2. Areas of Natural Beauty are defined in the Principles and Standards (p. 33) as:

> "Management, protection, enhancement, or creation of areas of natural beauty and human enjoyment such as open and green space, wild and scenic rivers, lakes, beaches, shores, mountain and wilderness areas and estuaries".

In addition to the linear, quantitative measurement effects of alternative plans on areas of natural beauty mentioned above, three basic aesthetic criteria of the natural environment are unity, variety and vividness. High quality natural landscapes are unified and possess an abundance of variety and vividness. Low quality landscapes lack these elements. Accordingly, specific probable effects of plans on unit variety of natural ingredients, and vividness in a landscape should be identified and described under appropriate headings.

The probable effects of plans upon visual qualities are related to the scale of the planning project. Level A and B study plans cover vast areas and assessment of their effects on regional landscapes must be approached on a "broad brush" basis. On the other hand, Level C studies normally cover smaller areas so the assessment of their effects on landscape values would be more detailed:

Some elements that could be used to evaluate Level B or C planning of landscapes are:

- Linear elements which are natural elements flowing in a straight line such as ridge lines or canyon walls.
- Area elements involving large surface areas.
- Mass elements such as a large even-textured rock cliff.
- Point elements across the landscape which are unique, singular, and eye-catching.
- Color and texture.

II. A Case Example of an:
(1) Abbreviated NED-EQ Evaluation Account·
(2) An Abbreviated EQ Plan and
(3) Evaluation Account

In the preceding pages the measurement of effects of alternative plans on components of the environmental quality objective were discussed. The components were: the physical land resources (soil stability, geological resources), air and water quality, ecological resources and culturally significant resources (historical and archeological resources and areas of natural beauty). Special attention was given to the ecosystem relationships and to the use of a common denominator called "habitat units" (HU) as a unit of measure for each ecosystem. The above discussion is helpful to an understanding of the following abbreviated case study example of the EQ evaluation accounts and and EQ plan for the Onaga Dam and Reservoir flood control project in Northeast Kansas. The case example inadequately treats the culturally significant resources in terms of the methodology present in the preceding section.

Plan A: NED-EQ Evaluation Account
(Part 1)

A. Physical Land Resources

1. Soil Stability: General soil erosion control in the Vermillion Creek drainage was not treated in Plan A formulation. The reservoir would, however, act as a large sediment trap for the drainage area, and to some degree, it would reduce the downstream sediment load. Some scouring of the lower portion of Vermillion Creek below the dam would still occur. Initially, some soil erosion would occur in the reservoir from wave action, particularly on the southeast shoreline. However, because of intensive limestone outcroppings which border the valley, this erosion would be expected to stabilize rather rapidly. During reservoir drawdown periods, esthetically undesirable mud flats would be exposed.

2. Geological Resources: The planning area is characterized by limestone ridges of the Permian and Pennsylvanian Age. The Nemaha anticline, a major post-Mississippian upwarping of bedrock strata, transverses the valley. In these geological formations are found sand, gravel, oil, and coal but, they are not commercially exploited in the planning area. The only geological change expected is gradual exposure of the limestone ridges around the edges of the reservoir due to wave action.

B. Air and Water Quality Standards

1. Air Quality: Violation of air quality standards is not expected to be a significant problem. Some unavoidable air pollution will occur from heavy equipment exhaust fumes and burning in the conservation pool.

2. Water Quality:

a. During construction of the dam and the clearing of brush and timber in the conservation pool, fifteen miles of Vermillion Creek and five miles of tributary streams will suffer significant turbidity and silt loads. These will be carried downstream in the Kansas River from the mouth of Vermillion Creek.

b. Plan A provides for an augmented minimum flow of 5 c.f.s. below the dam. No significant changes in temperature, dissolved oxygen, or mineralization is expected in the reservoir releases. The outlet works will include multi-level intakes below the surface of multi-purpose pool, so that selected lake waters can be taken to maintain the above controls.

c. Silt storage in the reservoir was discussed under physical land resources. After project construction due to reservoir sediment entrapment, silt and turbidity inflow to the Kansas River will be reduced.

d. When the ground water zone is recharged from reservoir construction, the water table could raise. However, increased water utilization from increased development around the lake could reduce this marginal rise in water table. Also, if impervious barriers are not present, any pollutants from sewage, etc. that enter the ground water aquifers could reach the lake. These problems were not adequately treated in formulating Plan A.

e. Plan A does not address the problems of the town of Onaga's effluent drainage into Vermillion Creek and pollution associated with livestock operations along Vermillion Creek and its tributaries.

C. Ecological Resources - Plan A (NED)

1. Terrestrial Ecosystems: The effects of Plan A are expressed in wildlife habitat units.

Habitat Component by Project Segment	Acreage	Net Annual Wildlife Habitat Units Lost or Gained
		(- or +)
Conservation Pool		
Forestlands	1,273	- 8,911
Croplands	3,651	- 20,811
Brome Pastures	277	- 866
Native Prairie	73	- 467
Streams	46	- 285
Sub-Total	5,320	*- 31,360
Flood Pool		
Forestlands	1,405	- 4,918
Croplands	2,743	- 7,132
Brome Pastures	693	- 901
Native Prairie	393	- 1,140
Streams	46	- 120
Sub-Total	5,280	*- 14,211
Below Dam (except Rec. Areas)		
Forestlands	259	0
Croplands	532	0
Native Prairie	232	0
Streams	17	0
Sub-Total	1,040	0
Rec. Area Below Dam		
Forestlands	94	- 461
Croplands	183	- 805
Native Prairie	78	- 359
Sub-Total	355	*- 1,625
Rec. Areas Above Flood Pool		
Forestlands	102	- 592
Croplands	137	- 617
Brome Pastures	16	- 40
Native Prairie	505	- 2,071
Sub-Total	760	*- 3,320
Above Flood Pool to Take-Line (except Rec. Areas)		
Forestlands	215	+ 215
Croplands	290	+ 290
Brome Pastures	33	+ 33
Native Prairies	1,072	+ 1,072
Sub-Total	1,610	*+ 1,610
Above Flood Pool & Above Take-Line Within 1 Mile of Conservation Pool for Target Year 25		
Forestlands	929	- 836
Croplands	164	- 115
Brome Pastures	148	- 74
Native Prairie	5,798	- 4,059
Streams	8	- 6
Sub-Total	7,047	*- 5,090

Grand Total--Terrestrial

Habitat Component	Acres	Total Net Wildlife H.U. Lost or Gained (- or +)	Annualized H.U. Values Lost or Gained (- or +)
Forestlands	4,277	-1,539,850	-15,399
Croplands	7,700	-2,917,563	-29,176
Brome Pastures	1,167	- 185,875	- 1,859
Native Prairie	8,151	- 651,663	- 6,517
Streams	117	- 41,025	410
Total	21,412	-5,335,976	*-53,361

*The wildlife habitat unit values are only additive for the calculation of mitigation needs when one of the following conditions exist: (1) An exception to the general policy of mitigating in-kind, or (2) The frequency distribution of habitat components in the lands proposed for mitigation purposes are comparable with those in the project area where the losses occurred.

2. Aquatic Ecosystems: The effect of Plan A will be expressed in aquatic habitat units.

Habitat Component By Project Segment		Acreage	Net Aquatic Habitat Units for Years 0 - 50 (- or +)
Below Dam			
Channelized Creek	(01)	14.2	+ 14.2
Unchannelized Ck.	(02)	3.1	+ 6.2
Conservation Pool			
Unchannelized Ck.	(02)	36.4	- 207.5
Tributary Streams	(03)	9.4	- 50.8
Flood Pool			
Unchannelized Ck.	(02)	28.4	- 68.2
Tributary Streams	(03)	18.1	- 38.0
Farm Ponds	(05)	1.0	- 1.0
Above Flood Pool			
Tributary Streams	(03)	108.7	0
Reservoir	(04)	5,320.0	+20,616.0

Grand Total--Aquatic Ecosystem

		Year 0 - 50		Year 50 - 100		Total Net H.U. Loss or Gain	Annualized H.U. Values Lost or Gained
		Acres	Net H.U. (- or +)	Acres	Net H.U. (- or +)	(- or +)	(- or +)
Channelized River	(01)	14.2	+ 14.2	-	-	+ 710	+ 14.2
Unchannelized River	(02)	67.9	- 269.5	82.1	- 255.3	- 26,240	262.4
Tributary Streams	(03)	136.2	- 88.8	136.2	- 88.8	- 8,880	88.8
Reservoir	(04)	5320.0	+20,616.0	5320.0	+ ,616.0	+ 2,061,600	+20,616.0
Farm Ponds	(05)	1.0	- 1.0	1.0	- 1.0	- 100	1.0

It was assumed that the channelized stream portion below the damsite would continue to meander, without the project, and after 50 years would return to a natural stream condition equivalent to that of the unchannelized portion. With the NED plan, the channelized segment was considered as an unchannelized segment after 50 years.

3. Special Ecosystem Relationships and Irreversible Commitments of Ecological Resources: The original native tall grass prairie was historically found in eleven midwestern States. At the present time, the Flint Hills of eastern Kansas and a small extension into Oklahoma contain the only significant remnant area of native tall grass prairie in North America.

The greater prairie chicken, *Tympanuchus cupido pinnatus*, originally flourished in the taller climax grasslands of the eastern great plains. However, as the native grasslands disappeared, the population dwindled. The bird is currently limited to several small isolated populations in Michigan, Wisconsin, Illinois, and the grasslands of southern Manitoba and northwestern Minnesota. A small declining population exists in North Dakota and another small population is holding its own in Missouri. The bird is hunted in South Dakota, Nebraska, Kansas, and Oklahoma. It is only in these States that the bird is considered safe.

The heart of the greater prairie chicken range is in the bluestem prairies of eastern Kansas. It is a zone of tall grass native prairie interspersed with croplands, associated woody draws and flinty, limestone hills. Three-fourths of the greater prairie chicken population in North America is found in Kansas, where in the Spring, population densities approximate 15 per square mile. This is compared to a population density in South Dakota of 2 to 4 per square mile.

Geographically, the planning area is located in a remaining portion of the native tall grass prairie in North America. The majority of the grasslands lie above the conservation pool. However, 466 acres will be lost in the reservoir area. A significant loss of prairie chicken habitat will be the irreversible commitment of 6,400 acres of croplands due to inundation. Croplands provide an important food supply for the prairie chicken during severe winter months. The most significant impacts on the grasslands would occur within one mile above the project takeline because of private developments. An estimated 10 percent of the existing terrestrial HU outside the takeline would be lost to such development.

In addition to grasslands, a total of 1,273 acres of forestlands, 3,651 acres of croplands, and 277 acres of brome grass pasture would be irreversibly lost to permanent inundation. Another 1,405 acres of forestlands, 2,743 acres of croplands, and 693 acres of brome grass pasture would be periodically inundated. Those habitat acreages below the 10 year flood storage frequency would be nearly 100 percent lost.

The energy center proposed by the Kansas Power and Light Company would be situated just east of the Onaga reservoir site in the adjacent drainage. Approximately 5,400 acres of additional native grasslands would be lost by the proposed energy center.

The completion of Plan A would also cause the loss of approximately 15 miles of free-flowing Vermillion Creek and 5 miles of tributary streams. An additional 13 miles of Vermillion Creek and 9 miles of tributary streams in the flood pool would be periodically inundated along with their associated fauna and flora.

4. Rare and Endangered Species: At this time neither the State of Kansas nor the U.S. Department of the Interior recognize any species of fauna or flora in the planning area that are threatened with extinction.

D. Culturally Significant Resources

1. Archeological Amenities: There are 96 known archeological sites within the project area. Many will be permanently inundated and lost forever because of the accelerated rate of decomposition. Damage to those sites at or slightly above conservation pool would also occur due to wave action and siltation. Sites above the flood pool may be adversely affected by increased human development, activity, and vandalism.

2. Historical Amenities: Historical sites within the project area include two gristmills of pre-1900 vintage, a Potawatomi Indian house from about 1850, two old cemetaries located below the damsite, and old grotto adjacent to another cemetary located in the flood pool, and the Vieux Crossing of Vermillion Creek on the Oregon Trail. Both gristmills and the Potawatomi Indian house would be inundated unless relocated. The two cemetaries and the grotto would be degraded due to increased human visitation and vandalism.

3. Areas of Natural Beauty: The native tall grass prairie that remains in the Kansas Flint Hills and a small portion of Oklahoma is a unique area of natural beauty. The project area lies within this native grassland region. Approximately 55 percent of the area influenced by the project is native grassland.

Plan A. would create a 5,320 acre reservoir in a rich agricultural valley which is surrounded by native bluestem grasslands with associated wooded draws and limestone outcropped hills.

The proposed reservoir at multipurpose pool level of 5,320 surface acres would permanently inundate 1,273 acres of forestland, 3,651 acres of cropland, 277 acres of brome grass pasture, and 73 acres of native tall grass prairie. An additional 1,405 acres of forestland, 2,743 acres of cropland, 693 acres of brome grass pasture, and 393 acres of native tall grass prairie would be periodically inundated at the full pool level of 10,600 surface acres. These habitat acreages below the 10 year flood storage frequency would be nearly 100 percent lost, and the area above would display soil erosion problems and esthetically undesirable mud flats.

Approximately 10 percent of the area influenced by the project above the takeline would be completely lost to commercial and residential developments by year 25. This would include 929 acres of forestland, 164 acres of cropland, 148 acres of brome pasture and 5,798 acres of native tall grass prairie.

The downstream area below the dam will have a reduced sediment load due to the reservoir acting as a giant sediment trap. The quality of water downstream and hence entering the Kansas River will be of higher quality. However, some scouring would occur downstream increasing the possibility of bank erosion.

Plan A: Abbreviated EQ Plan
(Part 2)

This plan calls for the development and/or the protection and preservation of the natural physical, biological, archeological and historical resources on 59,732 acres in the Vermillion Creek Valley in northeastern Kansas.

A. Physical Land Resources

1. Soil Stability: Approximately 82 percent of the Vermillion Creek Valley bottomland is in agricultural crops. Another 10 percent is in pasture with the remaining acreage in bottomland hardwood forest. The Pottawatomie County Soil Conservation Service personnel indicate that only 30 percent of the land in the Vermillion Creek valley has adequate soil erosion controls. Much of the cropland extends to the banks of Vermillion Creek and its tributaries. The soil erosion rate for the Vermillion Creek cropland is approximately 18 tons per acre per year. Cattle and hog lots located on the stream banks cause a significant loss of soils through bank erosion. The primary objective of the soil conservation plan is to reduce the soil erosion rate to less than 4 tons per acre per year for agriculture cropland and to less than 1/2 ton per acre per year for pasture and native grasslands.

a. Cultivated land erosion control:

(1) A total of 881 acres of cropland will be converted to native grass buffer strips between stream banks and croplands. This includes the development of meandering grass strips approximately every 1/4 mile through the valley bottom croplands. As a benefit to wildlife, in most situations native forbs and legumes would be encouraged. Where grassland strips serve as grassed waterways, substitute plans species may be necessary.

(2) Croplands with a greater than "X"% slope and containing intermediately erodable soils would be terraced, retired from cultivation, or the land use practices changed to crops that are more compatible with good soil conservation practices.

b. Stream bank erosion control:

(1) Eroded stream banks located in livestock feed lots would be fenced to exclude livestock and seeded to native prairie grass and brush to stabilize the soils.

(2) Stream bank erosion occurring elsewhere would be slowed by willow plantings, physical barriers, and/or the topping of those trees that are contributing to the bank sloughing problem.

c. Range and pasture erosion control:

(1) Regulate numbers and distribution of livestock to protect against soil erosion resulting from over-grazing.

(2) Develop strategically located headwater ponds in eroded areas to trap erosion sediment. These special ponds would also aid in the distribution of livestock for more even range utilization especially when salting stations are located in the proper juxtaposition to the ponds.

2. Geological Resources: The planning area is characterized by limestone ridges of the Permian and Pennsylvanian age. The Nemaha anticline, a major post-Mississippian upwarping of bedrock strata, traverses the valley. In these geological formations are found sand, gravel, oil, and coal. However, they are not commercially exploited in the planning area.

Since significant exploitation of the geological resources is not expected, programs of the EQ plans are not directed toward preserving these resources.

B. Air and Water Quality Standards

1. Air Quality: No significant air pollution problems were found in the planning area.

2. Water Quality: The primary objective is to increase the water quality of the Vermillion Creek drainage to meet the water quality standards of EPA and the Kansas State Board of Health.

a. Enforce water pollution laws

(1) The fecal coliform counts immediately below the Onaga municipal sewage effluent discharge would be reduced from a moderately high level of 75,000 per 100 ml to 200-400 per 100 ml.

(2) Runoff from livestock feedlots would be controlled to meet EPA and Kansas State Department of Health standards.

(a) Provide settling basins (livestock owners).

(b) Provide proper fencing of stream and stream banks (livestock owners).

(3) Minimum stream flow data in the drainage would be established. Water use from streams would be controlled during periods of critical low stream flow.

(4) The high phosphate-phosphorous at "Z" (level) would be reduced to "X" (level).

(5) The high manganese at "X" (level) would be reduced to .05 ppm.

(6) The high hardness at 200-300 ppm would be reduced to 150 ppm.

b. Turbidity in Vermillion Creek and its tributaries is 15-50 Jackson Units. The Plan B - EQ would reduce turbidity during intermediate flood flows to 20 Jackson Units.

(1) Arrest stream turbidity caused by soil erosion from terrestrial sources.

(a) Control soil erosion from cultivated land. A total of 881 acres of croplands would be converted to native prairie grassland strips as quasi sediment traps between the streams and croplands. Included in the 881 acre conversion of croplands would be the development of meandering native grassland strips approximately every 1/4 mile through the valley bottom croplands. Where feasible as a wildlife benefit, forbs and legumes would be encouraged. Where the native grassland strips serve as grassed waterways, a substitution of plant species may be necessary. Also, those croplands with greater than "X"% slope and containing intermediately erodible soils would be terraced, retired from cultivation, or the land use practices would be changed to crops that are more compatible with good soil conservation practices.

(b) Control livestock caused soil erosion. Eroded stream banks located in livestock feedlots would be fenced to exclude livestock and seeded to native prairie grass and brush to stabilize the soils and to benefit wildlife. Also, regulate the number and distribution of livestock to control over-grazing. Over-grazing contributes to the problems of soil erosion and stream turbidity.

(c) Develop stategically located headwater ponds to trap the sediments in the general vicinity where the erosion is occurring. This would also help in regulating livestock distribution.

(2) Stream bank erosion caused by stream currents would be slowed by the development of willow plantings, physical barriers, and/or topping of trees that contribute to the stream bank sloughing problem.

C. Ecological Resources

1. Terrestrial Ecosystems:

a. The primary objective of the planned terrestrial ecosystem development is to increase the carrying capacity of the greater prairie chicken habitat approximately 60 percent. The following steps would be taken to accomplish the objective of developing an intensive prairie chicken habitat management program.

(1) Enlisting 80 percent of the prairie grassland owners into a cooperative grassland management program, and

(2) Developing an extension bulletin that outlines the economic benefits of intensive grassland management and the contributions of this management to the EQ plan emphasizing the following aspects:

-Range condition and utilization vs. beef production
-Range condition vs. prairie chicken populations
-Range condition vs. other wildlife populations

-Range condition vs. soil stabilization and water quality

-Pictorial index to range condition

(3) Enter into legally binding 100-year cooperative grassland management programs with grassland owners by:

-Contacting all grassland owners and selling a cooperative grassland management program, and

-Having grassland owners sign cooperative agreements.

(4) Execute a cooperative agreement emphasizing:

-A program to regulate livestock numbers and/or distribution to increase plant vigor and species diversity of native grasses and forbs. Regulated grazing would also increase long-range economic returns to the livestock operators in terms of beef production. Observations of the planning area indicate that under present grazing practices from 50 to 75 percent of the native grasslands are being over-utilized.

-Employment of a system of controlled burning except on approximately 3,160 acres of grassy draws to control plant diversity and improve plant vigor. This practice would be cost-shared by Federal and State governments. Burning during the early part of April would produce the highest percentage of forbs and remove the dense accumulated ground litter. The prairie chicken population depends on grasses and forbs in the summer and fall for about 85 percent of its food supply. Insects (grasshoppers) make up the remainder.

-Provide an additional critical winter food supply for prairie chickens on 294 acres of strategically located croplands purchased in fee title. Sorghum and corn crops would be planted annually and left unharvested. In addition, provide 20 acres of strategically located food plots located in the grasslands planted annually and left unharvested.

(5) In conjunction with the EQ prairie chicken habitat improvement program would be the vigorous enforcement for the protection of the prairie chicken.

(6) Develop a comprehensive greater prairie chicken management handbook emphasizing the life history, distribution, and life requirements, population dynamics, habitat management, and population management.

b. The first terrestrial ecosystem objective subordinate to the primary objective is to increase the habitat carrying capacity for bobwhite quail by 30 percent and rabbit by 20 percent. The steps to accomplish this objective are:

(1) The controlled burning of the grasslands under the prairie chicken habitat management program will also benefit these species.

(2) Under the prairie chicken habitat managment program the 295 acres of crops left unharvested in the bottomlands and the 20 acre food plots planted in the uplands would benefit both quail and rabbit.

(3) A total of 3,160 acres of grassland draws or ravines would not be burned allowing brush to invade the grassy draws. Cattle would be inclined to utilize the stimulated grass forage on the hill tops, which would further accelerate the invasion of brush in the draws. The brushy draw habitat would provide escape and roosting cover and a supplemental winter food supply for quail and rabbit.

(4) A total of 881 acres of croplands would be converted to native grassland strips along the creek and tributaries and along the edges of some of the bottomland hardwoods. As outlined under the soil stability plan, strips would be developed every 1/4 mile through the croplands in the valley bottom. Where feasible native forbs and legumes would be encouraged for wildlife benefits. The grassland strips would be managed primarily for quail and rabbit. Density of the grass strips would be managed to provide nesting, escape, and roosting cover and burned when the litter accumulation becomes too thick on the ground.

(5) Fence rows between or beside croplands would be converted to narrow strips of brushy habitat. This would serve as roosting cover for bobwhites and escape cover for rabbits as well as provide windbreaks to the croplands.

c. The second terrestrial subordinate objective is to increase the white-tailed deer carrying capacity by 100 percent and fox squirrel carrying capacity by 20 percent. White-tailed deer is the only big game animal found in the planning area. The steps to reach this objective are:

(1) The grassy draws would not be burned, expediting the succession of 3,160 acres to brushy draws by the 10th year. This would provide cover and browse for deer.

(2) Eight oak trees per acre would be planned in the 3,160 acres of newly converted brushy draws for future production of mast for winter food supply for deer and squirrel.

(3) Improvement of the forestland habitat in general would be accomplished by wildlife oriented Timber Stand Improvement (TSI). All den trees would be preserved.

(4) The 294 acres of unharvested cropland would also provide an additional food supply for deer and squirrel during the critical winter period.

d. The third terrestrial subordinate objective is to increase furbearing animal populations by 20 percent. This can be accomplished as follows:

(1) Water oriented furbearers:

(a) Beaver--in conjunction with willow plantings to control stream bank erosion, additional plantings would be made to provide food supply for beaver.

(b) Muskrat--the 294 acres of unharvested crops left along stream banks would serve as food supply for muskrats.

(c) Mink--no emphasis would be placed on management for mink. However, the EQ evaluation account would show that mink would benefit from other management practices.

(d) Raccoon--a special TSI program would be used to selectively manage for den trees on both old and new forests. Where den trees did not exist, a raccoon nest box would be place every 1/4 mile along the stream banks. Provide a greater food supply to the raccoon population by planting in scattered areas elderberry bushes in the 881 acres of newly converted native forb and legume grassland strips and in fence rows adjacent to stream banks.

(2) Land oriented furbearers:

(a) Coyote, fox, skunk and other predators.

-The conversion of 3,160 acres of grassy draws to brushlands would increase cover for these animals and increase the small mammal populations resulting in an increased food supply.

-The conversion of 881 acres of cropland to grassland is expected to also increase small mammal populations, hence an additional food supply for predators.

-The creation of brushy fence rows between and beside croplands will increase prey species populations for predators.

e. The fourth terrestrial subordinate objective is to increase the carrying capacity of the habitat for non-game birds by 30 percent in the following manner:

(1) Conversion of 3,160 acres of grassy draws to brushy draws.
(2) Special TSI on forestlands.
(3) Conversion of 881 acres of croplands to grasslands.
(4) Leaving 294 acres of croplands unharvested.

Other terrestrial subordinate objectives would include:

f. The increase in rodents and other prey species providing a food supply for birds of prey such as hawks and eagles.

g. Incidental benefits to waterfowl as a result of Plan B might benefit waterfowl. However, waterfowl were not a consideration in the plan because a habitat improvement program designed for waterfowl in this planning area would only redistribute present numbers rather than increase production. Waterfowl might benefit because:

(1) The 294 acres of unharvested cropland might provide an additional food source for waterfowl.

(2) The creation of farm ponds in the upper watershed might serve as resting areas for migratory waterfowl.

2. Aquatic Ecosystem: The primary objective of the aquatic ecosystem portion of Plan B - EQ is to increase the desirable fish populations in Vermillion Creek by twenty (20) percent. This would be accomplished in the following manner:

a. Increase the water quality of the Vermillion Creek drainage to meet Environmental Protection Agency (EPA) and the Kansas State Health Department standards through control of the:

(1) Sewage effluent from the Town of Onaga into Vermillion Creek, and

(2) Effluent from cattle and hog feed lots into Vermillion Creek and its tributaries by livestock owners providing settling basins and by fencing grazing areas to control runoff and erosion.

(3) Turbidity levels to twenty (20) Jackson Units during intermediate flood levels in the Vermillion Creek drainage through arresting soil erosion from terrestrial and aquatic sources.

(a) Control of erosion from terrestrial sources, i.e. from i) cultivated lands, ii) livestock, and iii) gully and ditch banks stabilization would be obtained as follows:

i) Cultivated Lands

-A total of 881 acres of cropland would be converted into native grasslands as quasi sediment traps between the stream banks and croplands. Also included in the 881 acres would be meandering native grassland strips developed approximately every 1/4 mile through the valley bottom croplands. Where conducive to wildlife, forbs and legumes would be planted to benefit wildlife.

-Croplands with a greater than 10 percent slope and containing intermediately erodable soils would be terraced, retired from cultivation, or the land use practices would be changed to crops that are more compatible with good soil conservation practices.

ii) Livestock

-Eroded stream banks located in livestock feedlots would be fenced and seeded to native grass and brush to stablilize the soils. Where feasible, forbs and legumes will be encouraged for the benefit of wildlife.

-Regulate livestock numbers and distribution to protect against over-grazing and resulting soil erosion problems contributing to turbidity in the aquatic ecosystem.

-Develop strategically located headwater ponds to trap the sediments in the general vicinity where the erosion is occurring. This would also help in regulating livestock distribution.

iii) Gully and Ditchbank Stabilization

-The planting of grasses, bushes, trees and other types of vegetation including physical structures would greatly facilitate the early stabilization of such exposed areas as gully and ditch banks.

(b) Control of erosion from aquatic sources. Fast and high stream currents causing bank erosion would be slowed by willow and other types of plantings including physical barriers. At the same time, these would tend to eliminate streambank sloughing problems. By such means, the minimum aquatic ecosystem stream flow levels concurrent with the requirements of the primary objective of the aquatic ecosystem would be maintained through:

-Establishing critical low stream flow levels on Vermillion Creek, and

-Controlled water use from streams during periods of critical streamflows.

In order to obtain the cooperation of landowners, farmers, and others, and to actually reach the objectives specified in both the terrestrial and aquatic ecosystems, it is essential - through Extension and other types of services - that the landowners understand the nature of assistance available from the U.S. Department of Agriculture (i.e. ASCS or SCS), such as:

-Free information services

-Cost-sharing

-Sponsoring annual program

-Long-term management or other types of agreements

b. Increase the availability of the streams and ponds for recreational use as provided for in the aquatic ecosystem as a complementary NED feature. This would be accomplished by:

(1) Acquiring nine public access corridors in fee title along Vermillion Creek. There would be 1/4 mile strip each way from the access points to provide for fishing and boat launching.

(2) Constructing access roads and parking space at strategically located points on five of the major tributary streams.

(3) Acquire four (4) farm ponds by fee title for public use and manage for bass, bluegill, and channel catfish. Access roads would be provided.

(4) Maintaining desirable species composition on other farm ponds. This may require rehabilitation and/or stocking, regulation and enforcement.

Culturally Significant Resources

1. Archeological Amenities

The Missouri River Basin Survey archeological team and the Kansas State Historical Society have located 96 archeological sites in the planning area. Of the total so far discovered, 87 are considered prehistoric in origin.

It is realized that the possibility of a future water development project is possible in the planning area, as well as continued use of the land for farming, road building, construction of gas and oil pipelines, possible mining of sand and gravel or coal, and many others. Any of these activities could, and in the case of a reservoir, would destroy many archeological amenities.

Realizing the yearly advancement of archeological interpretive techniques, the EQ plan provides for an archeological salvage work contingency to obtain and preserve important archeological sites, specimens, and data before they are destroyed by future land use changes. In the event the salvage work is needed, e.g., the development of a 5000 acre reservoir, a minimum of three eight-week field seasons of archeological exploration would be conducted in the Vermillion Creek valley. At least 12 of the 96 sites should be excavated and at least an additional 28 tested. Archeological data should be recorded from the remaining 56 sites by the year 15.

2. Historical Amenities

Important historical sites within the planning area include two gristmills of pre-1900 vintage, a Potawatomi Indian House from about 1850, two old cemetaries, an old grotto, the Vieux Crossing of Vermillion Creek on the Onaga Trail, and the historic towns of Laclede and Onaga.

As with archeological amenities, future planning in the area could disrupt any of these historical sites. A reservoir in the Vermillion Creek valley would most likely inundate and destroy the gristmills, and the Potawatomi Indian house. Increased vandalism to the other sites would also be expected.

A feature of this EQ plan would be to preserve these historical amenities.

a. The sites of the two gristmills and the Potawatomi Indian house located on these sites would be acquired by the State Historical Society. If future land use changes so dictate they would be relocated.

b. The two old cemetaries and the grotto would be developed as points of interest for those visiting the Vermillion Creek valley.

c. The Oregon Trail crossing on Vermillion Creek would be preserved and maintained as a State Park and point of interest for the public. Land acquisition would be necessary in this area.

3. Areas of Natural Beauty

The planning area is in the unique native tall grass prairie of the Kansas Flint Hills. The EQ plan would preserve and enhance 32,098 acres of the native tall grass prairie. Included in this total are 881 acres of cropland that would be converted to native grasslands. These additional grasslands would be developed as strips along the bottomland hardwoods and stream banks and every one-fourth mile in a meandering fashion through the croplands. Native forbs and legumes would be included in the grassland strips. The forestlands would be increased by 3,160 acres. In addition, specialized Timber Stand Improvement (TSI) on 12,662 acres of general forestlands would help retain the aesthetic value of the forestlands.

With the control of pollution from point and non-point sources into Vermillion Creek and its tributaries, the natural beauty of approximately 120 miles of streams would be preserved and enhanced in the planning area.

As a result of the increase in habitat quality almost all wildlife populations would increase significantly.

Plan B - EQ: Abbreviated EQ Evaluation Account
(Part 3)

Physical Land Resources

1. Soil Stability: Under Plan B, erosion of agricultural cropland in the Vermillion Creek drainage will be reduced to 4 tons per acre per year, pasture and native grassland to less than 1/2 ton per acre per year.

2. Geological Resources: No change is anticipated in the geological resources of the planning area as a result of Plan B and/or in the future without any plans.

Air and Water Quality Standards

1. Air Quality: The spring grassland burning program of this plan would produce a considerable amount of smoke. However, grassland fires are historically considered a natural phenomenon.

2. Water Quality: EPA and Kansas State Board of Health water quality standards will be met or exceeded. The turbidity goal in Jackson Units for intermediate flood waters will be reached.

Ecological Resources

1. Terrestrial Ecosystem: The effect of Plan B is expressed in wildlife habitat units.

	Acreage	Total Net Habitat Unit Lost or Gained	Annualized Habitat Unit Lost or Gained (- or +)
Forestlands	12,662	+ 3,681,265	+ 36,813
Croplands	14,779	+ 2,982,300	+ 29,823
Brome Pastures	0	- 881,600	- 8,816
Native Prairies	32,098	+ 7,348,325	73,483
Streams	193	+ 9,600	+ 96
Total	59,732	+13,139,890	+131,399

2. Aquatic Ecosystem: The effect of Plan B is expressed in aquatic habitat units.

		Year 0 - 50		Year 50-100		Total Net Habitat Unit Lost or Gained	Annualized Habitat Unit Lost or Gained (- or +)
		Acres	Net H.U. (-or+)	Acres	Net H.U. (-or+)		
Channelized Creek	(01)	14.2	+ 8.5	-	-	+ 425	+ 8.5
Unchannelized Creek	(02)	67.9	+40.7	82.1	+49.2	+ 4,495	+ 44.9
Tributary Streams	(03)	136.2	+68.1	136.2	+68.1	+ 6,810	+ 68.1
Farm Ponds	(05)	127.0	+63.5	127.0	+63.5	+ 6,350	+ 63.5
Total		472.3		345.3			+185.0

With Plan B, it was assumed that the channelized stream segment would continue to meander, and after 50 years would return to a natural stream condition equivalent to that of the unchannelized segment. After year 50, the channelized segment was included with the unchannelized segment.

3. Special Ecosystem Relationships and Irreversible Commitments of Resources: The original native tall grass prairie was historically found in eleven central midwestern States. The native tall grass prairie is a fire climax seral stage. If fire is suppressed, plant succession proceeds to brushlands to juniper to an oak-hickory climax.

Historically, the native tall grass prairies were maintained by natural and man-made fires. However, since the turn of the present century, man has significantly reduced the native prairie acreage by plowing the prairies to raise agricultural crops. At the present time, the Flint Hills of eastern Kansas and a small extension into Oklahoma contain the only significant remains of the tall grass prairie in North America.

Plan B would enhance and preserve the unique native tall grass prairie ecosystem of the Vermillion Creek valley in northeastern Kansas.

Geographically, the planning area is located in what is left of the native tall grass prairie in North America. It provides an ecotone of natural bluestem interspersed with croplands, associated wooded draws, and flinty, limestone hills.

The greater prairie chicken, Tympanuchus cupido pinnatus, is indigenous to the native tall grass prairies of the eastern great plains. However, the reduction in habitat has severely restricted the geographic distribution of the bird.

Currently, small isolated populations of the bird exist in Michigan, Wisconsin, Illinois, southern Manitoba, northwestern Minnesota, North Dakota, and Missouri. Huntable populations only occur in South Dakota, Nebraska, Kansas, and Oklahoma.

The heart of the greater prairie chicken range is in the bluestem prairies of the Flint Hills of eastern Kansas. Three-fourths of the total North America population is found in Kansas in spring densities of approximately 15 chickens per square mile. In comparison, South Dakota maintains a population density of about 2 to 4 birds per square mile.

Plan B would increase the carrying capacity for prairie chicken by 60%. To accomplish this some land use changes would have to take place.

Plant succession would be allowed to advance to the brushland seral stage in 3,160 acres of grassy draws. A total of 881 acres of croplands would be reverted back to native grasslands in buffer strips and grassed waterways. Fence rows would be managed for the brushland seral stage. A total of 314 acres of supplemental food supplies in the form of unharvested agriculture grain crops and food plots would be guaranteed. Wildlife oriented Timber Stand Improvement work would be conducted on the forestlands. Effort would be put forth to produce and preserve fruit and mast bearing trees, especially trees with cavity or den producing tendencies. Willows would be planted along the stream banks as a supplemental food source for beaver and as a soil stabilizer.

4. Rare and Endangered Species: At this time neither the State of Kansas nor the U.S. Department of the Interior recognize the existence of any threatened species of fauna in the planning area. The greater prairie chicken, however, is a close sub-species of the endangered-Attwater prairie chicken that is limited to isolated populations along the coast of Texas.

Culturally Significant Resources

1. Archeological Amenities: Plan B would not have an adverse effect on archeological amenities. It does provide for an archeological salvage work contingency to find and preserve important archeological sites, specimens, and data when eminently threatened.

2. Historical Resources: Plan B would not have an adverse effect on historical resources. It does provide a positive program, to preserve two gristmills of pre-1900 vintage, a Potowatomi Indian house dated about 1850, two old cemetaries, an old grotto and the Oregon Trail crossing of Vermillion Creek.

3. Areas of Natural Beauty: Plan B has a positive program to preserve and enhance 32,098 acres of the unique native tall grass prairie of the Kansas Flint Hills. The plan requires the conversion of 881 acres of croplands back to native grasslands in the form of cropland buffer strips and grassed waterways. The grassland burning program would have a very short-term effect on the aesthetic value of the grasslands. However, the native tall grass prairie is a fire climax seral stage, which is maintained only by fire. If fire was completely suppressed, the grasslands would succeed into brushlands.

The forestlands would be increased by 3,160 acres. The aesthetic value of the forestlands would be increased by specialized TSI work. Significant pollution sources, from sewage effluent, from the Town of Onaga and runoff from several livestock feedlots into the Vermillion Creek and its tributaries would be controlled. Soil erosion would be controlled through physical and biological means.

This would enhance the aesthetic value of approximately 120 miles of streams in the planning area. As the result of the increase in habitat quality there would be significant increases in almost all wildlife populations.

III. Significance of the Measurement of Effects of Alternative Plans on Environmental Quality (EQ Evaluation Account) in Water and Related Land Resource Planning

A. Scoping and Formulation of Alternative Plans:

The resulting displays in an EQ evaluation account will be a barometer of the beneficial and adverse effects of each alternative plan on the natural environment. This will specifically help Step #5 in the plan formulation process where the planner is to review and reconsider, if necessary, the specified components for the planning, setting and formulating of additional alternative plans as appropriate or modify the alternative plans already formulated.

B. Comparing Alternative Plans:

The evaluation accounts will display the full range of tradeoffs within and between alternative plans. This will:

1. Allow the public to make a more informed choice or expression of preference.

2. Provide a better frame of reference for the decisionmakers in his selection of a recommended plan or Congressional authorization of an alternative plan.

3. Document tradeoffs made in plan selection and authorization.

Note: This is why it is important in the planning process to first formulate a maximized EQ plan and a maximized NED plan.

C. Developing Data Needed for Environmental Impact Statement.

OVERALL ISSUES AND METHODS OF MEASUREMENT

Dirk P. Lijesen
Consultant, INTASA
Menlo Park, California

The purpose of this paper is to discuss the implications associated with the requirement of measuring and displaying regional development effects as described in the Principles and Standards (Reference 1). To set the tone for this discussion the section on orientation briefly summarizes the orientation of the discussion. A following section provides a detailed account of the text of the Principles and Standards and discusses it's applicability. Subsequently, another section approaches the measurement of Regional Development effects in light of the overall planning and evaluation process for water and related land resource development. This is followed by a section which highlights specific measurement problems and makes the connection with particular disciplines conventionally related to the measurement of regional development effects. Finally, the last section draws a number of conclusions and points to areas of further research.

Orientation

The orientation of this session is captured in the following points:

- A discussion of regional development effects should be oriented towards clarifying the intent underlying the Principles and Standards. The Principles and Standards can be seen as a first step towards incorporation of important issues and concerns that previously were not included in the planning process and that gave rise to distortions in water and related land development policies. By no means does this initial step provide a complete "cookbook", i.e., a set of specific instructions to the planner/evaluator that will accomplish the job of measuring RD effects.
- Having made an important first step towards recognizing the significance of regional development effects the next logical

step is to systematically investigate what type of procedures are available to implement the Principles and Standards. This requires further specification of the effects to be measured and exploration of "regionally oriented" scientific disciplines in terms of their possible role in the measurement process. In addition, and possibly more important, it requires the development of new procedures because in a number of areas covered by the Principles and Standards there, simply, is no concensus or methodology as to how to measure effects.

Neither a discussion of RD effects nor the measurement of such effects can be held without regard to the entire planning and evaluation process of which measurement is a part. Conversely it is considered important to structure the discussion by making explicit the connection with the planning and evaluation process. This connection provides the logical guidelines as to the extent that the planner/evaluator should address regional development effects.

Finally, and even after casual reading of the Principles and Standards, it is clear that each of the RD components relates to heavily debated policy issues such as shifts in regional income to promote some type of equity between regions. Consequently, the scope of the regional development account is broad. Measurement of RD effects should be considered in light of providing the information base that will shed light on such policy issues. Although regional development is not an "official" objective, it is advocated that this policy perspective is maintained as contrasted to the mere provision of "numbers and facts" to satisfy established Federal requirements. In this respect "numbers and facts" will become meaningful if their relationship to policy making is transparent.

Description/Definition of the Regional Development Account

The purpose of this section is to focus solely on a description and/or definition of the Regional Development account as provided in the Federal Register. The objective is to critically review the text so as to surface the rationale and content of this account.

A. Principles and Standards

Table I contains the text of the Principles regarding Regional Development. The following is noted.

- In the opening paragraph the words beneficial, adverse, relevant and appropriate are used. It is not clear how these words are to be further defined nor what value judgments have already been incorporated in this display account. Clearly, further discussion is necessary to determine if it is "appropriate" to display or what constitutes a relevant planning region. Value judgments are necessary in designating certain effects as beneficial or adverse. Confusion can be lessened if such judgments are clarified.
- The Principles call for measurement of changes in regional income. These relate to a static income objective. Freeman and Haveman note:

  > "In general, objectives concerning income can be static or dynamic. Static income related to objectives include changes in national income, changes in aggregate regional income, and changes in the distribution of income among persons or regions. Dynamic income related objectives refer to the rate of growth of national, regional, or per capita income over time. Economic development, whether regional or national, is conventionally defined as an increase in the rate of growth of aggregate income. Hence development is a dynamic concept. The difference between static and dynamic is not an unimportant issue, because the design and decision variables related to a dynamic objective may be quite different from those associated with a static objective. For example, for a given project a reduction in the proportion of total costs that must be repaid by beneficiaries in the region can have a substantial effect on regional incomes without necessarily affecting the rate of growth of regional income in the future." (Reference 2)

  The importance of the above distinction is further illustrated by the simple question: "What does it mean to the decision makers if a change in regional income is displayed?"
- Explicit reference is made to external (dis)economies and to the accounting of effects in the project region, the adjacent region and the rest of the Nation. Both are sound steps towards improvement of the planning and evaluation process, i.e., the proper measurement of effects and their spatial distribution. However

Table I

THE PRINCIPLES

TEXT	NOTES
"The following beneficial or adverse effects of the proposed plan on a system of relevant planning regions (States, river basins, or communities) will be displayed where appropriate.	• Definition of what is beneficial, adverse, relevant and appropriate is not clear.
a. Income effects (1) Beneficial. (a) The value of increased outputs of goods and services resulting from a plan accruing within relevant regions; and	• Change in regional product or regional income is called for. Not the rate of change, conventionally defined as RD. Development is dynamic Δ; income is static.
(b) The values of output resulting from external economies accruing within relevant regions.	• Explicit mention of external (dis)economies. Traditionally hardest to incorporate.
(2) Adverse. (a) The value of resources within relevant regions required for or displaced by a plan.	• Explicit reference to shifts among regions.
(b) Losses in output resulting from external diseconomies within the relevant regions.	
b. Beneficial and adverse effects on other components of regional development.	• What are other specified components of RD.
(1) The number and types of jobs resulting from a plan in the region under consideration;	
(2) Effects of the plan on population distribution within the region under consideration and among regions in the Nation;	
(3) The effect of the plan on the economic base and economic stability of the region under consideration;	
(4) The effect of the plan on the environment in the region under consideration; and	
(5) The effect of the plan on other specified components of regional development."	

it should be recognized that traditionally these areas of investigation are the hardest to deal with and consequently little or no advancement has been accomplished.

- Finally, it is not clear what "other specified components of R.D." consist of.

B. The Standards

The Standards expand on the Principles by providing more detail regarding the effects to be included in the RD account and by indicating the type of indicator and measurement methodology to be used. Table 2 summarizes the Standards along those lines. The reader is asked to review this table so as to become familiar with the type of effects to be included in the Regional Development account.

C. Applicability of RD Measurements

As in the case of the National Economic Development and Environmental Quality objectives the measurement of Regional Development effects applies to the three levels of planning studies established by the Water Resources Council. That is: (1) Framework studies, (2) Regional or river basin plans and (3) implementation studies. These have been defined as follows:

> "Framework studies and assessments are the evaluation or appraisal on a broad basis of the needs and desires of people for the conservation, development, and utilization of water and land resources and will identify regions or basins with complex problems which require more detailed investigations and analysis, and may recommend specific implementation plans and programs in areas not requiring further study. They will consider Federal, State and local means and will consider both national economic development and environmental quality objectives.
>
> Regional or river basin plans are reconnaissance-level evaluation of water and land resources for a selected area. They are prepared to resolve complex long-range problems identified by framework studies and assessments and will vary widely in scope and detail; will involve Federal, State, and local interests in plan formulation; and will identify and recommend action plans and programs to be pursued by individual Federal, State and local entities. They will consider both national economic development and environmental quality objectives.

Table II

SUMMARY OF STANDARDS WITH RESPECT TO THE RD ACCOUNT

Component	Type of Effect	Suggested Indicator	Suggested Methodology	Comments Made
Regional Income	- Increase in income due to increased outputs of goods and services.	- Dollar Value	- Same as for evaluation where the methodology is developed in some detail for each purpose.	- Include value to region of labor resources used in construction or installation of plan that would otherwise be unemployed or under employed. - Include additional net income to region for construction of plan and other induced activities.
	- Increase in income resulting from external economies in region.	- Dollar Value	- Same as for NED evaluation, however, no specific methodology is mentioned.	
	- Decrease in income equal to value of resources required or displaced to achieve plan output.	- Dollar Value	- Same as for NED evaluation.	- Include regional payment for resources contributed from outside region. - Include loss of assistance payments from outside the region to otherwise unemployed regional labor resources. - Include losses in regional output due to displaced and subsequently unemployed resources. - Include losses in regional net income due to regional economic activities displaced by construction or operation of plan.
	- Decrease in income due to losses in output resulting from external diseconomies in region.	- Dollar Value	- Same as for NED evaluation, however, no specific methodology is mentioned.	
	- Regional incidence of NED	- Dollar Value	- Determine geographic location or beneficial and adverse NED effects in relevant region and rest of Nation.	Note: Strictly, regional incidence is not an effect but indicates where the NED effects take place.
	- Transfer Effect	- Dollar Value	- Estimate transfer as fraction of the more direct project outputs on the region being considered. The fraction can be determined from input-output, economic base or Keynesian multiplier studies.	- The three approaches provide comparible results. WRC is to provide information on the appropriate multiplier values to use for specific planning studies.

Table II (continued)

Regional Employment	- Changes in rates of unemployment and related underemployment.	- Change in number and types of job resulting from plan.	- No specific methodology is mentioned.	- Where possible categorize the changes by relevant service, trade, and industrial sectors, with separate estimate for agricultural employment. - Classify nature of change with respect to level of skills where practicable. - Classify further in terms of age, sex, average wages and labor force participation rates.
Population Distribution	- Population Dispersal including changes in the urban-rural	- Change related to a goal in the geographic distribution of population and employment.	- No specific methodology is mentioned.	- Specific distributional goals of maintaining the rural population base and drawing more people into outlying areas are stated. They are to be used in judging the beneficial or adverse nature of the resulting distribution.
Regional Economic Base and Stability	- Diversity of economic base. Effects of interest include: (1) balance of local and regional economies, (2) regularization of market activity and employment fluctuations, (3) effects and accompanying uncertainty, (4) change in community growth.	- No specific single indicator included although it is suggested that beneficial and adverse effects are measured by comparative indices relating to fluctuations in output, employment and prices.	- No specific methodology is mentioned.	- Planning reports are to include: (1) Statisitcal description of the area's current economic base, highlighting the employment concentrations of concern, (2) Projections of future employment with and without the plan, (3) The percentage reduction in the area's expected dependence on its specialized type of employment, with as compared to without the plan.
Environmental Conditions of Special Regional Concerns	- Similar to EQ account with emphasis on regional incidence.	- Quantitative and qualitative physical descriptions.	- Similar to EQ account.	

> Implementation studies are program or project feasibility studies generally undertaken by a single Federal, State or local entity for the purpose of authorization or development of plan implementation. These studies are conducted to implement findings, conclusion, and recommendation of framework studies and assessments and regional or river basin studies which are found to be needed in the next 10 to 15 years. As with framework studies and regional or river basin plans, they will consider both national economic development and environmental quality objectives."

Measurements of RD effects is called for in specific cases. The Principles and Standards state:

> "The regional development account embraces several types of beneficial effects, such as (a) increased regional income; (b) increased regional employment; (c) population distribution; (d) diversification of the regional economic base; and (e) enhancement of environmental conditions of special regional concern. There are major difficulties in estimating some components of the regional development account, such as the location effects as well as estimating the effects of a plan on regional employment, population distribution, and economic base and stability. For this reason a complete display of beneficial and adverse effects for all components in the regional development account will not be made for a plan unless directed by a Department Secretary or head of an independent agency."

Measurement of RD Effects in the Planning and Evaluation Process

The previous section has clarified what type of effects fall within the RD account. In doing so, the connection with water resource plans has been tacitly assumed. To identify and measure RD effects in a particular planning context it is necessary to surface this connection explicitly; i.e., to determine how impacts and, in particular, RD effects come about. To provide a benchmark for this determination the following subsections discuss the planning and evaluation process and the impact assessment process.

A. A Planning and Evaluation Framework

Major elements of the planning and evaluation process are depicted in their simplest form by the blocks in Figure 1. Central to each step in the process is the use of specific planning objectives which result from the need identification phase as indicated in the Figure. In formulating alternative plans, planning objectives provide direction to the study.

In assessing impacts, planning objectives provide a first indication of the impact areas to be analyzed. In evaluation, planning objectives provide the criteria for identification of benefits and costs and for comparing alternative plans. In display, planning objectives form the most important category. Finally a well chosen set of planning objectives enhances the ultimate likelihood of implementing the recommended plan.

Starting with a preliminary formulation, the planner proceeds in an iterative manner (as indicated by the feedback loop in Figure 1) towards a further specification. That is, on the basis of alternative benefits and costs or on the basis of trade-offs among plans, it may be necessary to repeat tasks within the need identification process, to reformulate planning objectives or to modify and expand the range of alternatives. As this iterative process continues, each step within the loop is performed in increasing detail. Each task does not necessarily receive the same level of treatment during each iteration, and the steps are not usually executed in a strictly sequential manner. Rather, the feedback loop is designed to uncover and strengthen weaknesses in plans already formulated. Briefly summarized the major steps entail the following:

1. Need Identification. Figure 2 gives a closer look at the need identification block of Figure 1. The function of need identification is to derive planning objectives for water resource plans that will be responsive to identified problems; this analytical effort is threefold: (1) analysis of public concerns to arrive at an understanding of desires and preferences; (2) analysis of resource management problems; and (3) analysis of functional water resource areas (flood control, water supply, etc.) as a means for resolving specific resource problems and for contributing to the satisfaction of public desires. Thus, need identification for water resource management is charged with analyzing resource problems and interpreting public concerns while recognizing the potential of water resource systems to alleviate both.

   Inputs are the same as shown for the complete procedure. Three types of planning objectives are indicated as outputs: (1) those expressed in quantitative terms and with reference to

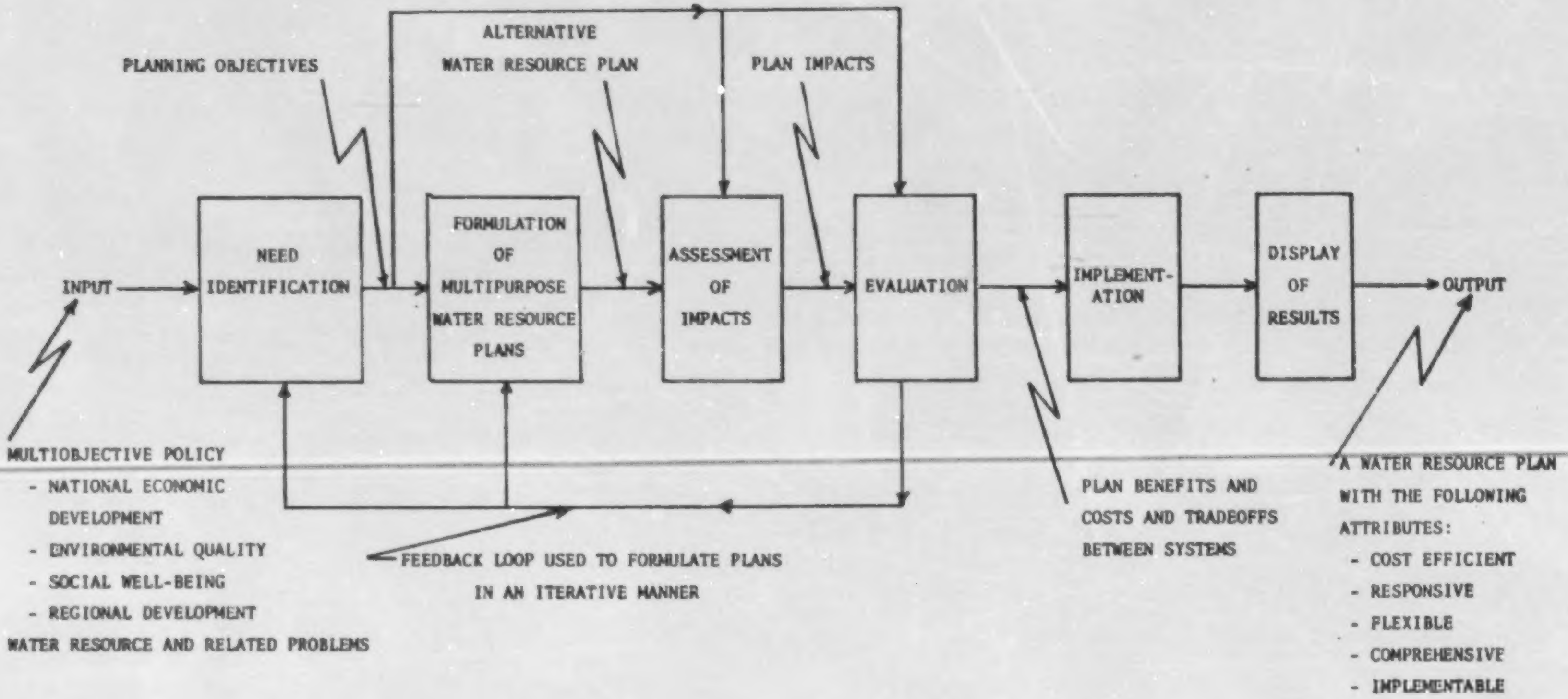

PLANNING OBJECTIVES
ALTERNATIVE WATER RESOURCE PLAN
PLAN IMPACTS
INPUT
NEED IDENTIFICATION
FORMULATION OF MULTIPURPOSE WATER RESOURCE PLANS
ASSESSMENT OF IMPACTS
EVALUATION
IMPLEMENTATION
DISPLAY OF RESULTS
OUTPUT
MULTIOBJECTIVE POLICY
- NATIONAL ECONOMIC DEVELOPMENT
- ENVIRONMENTAL QUALITY
- SOCIAL WELL-BEING
- REGIONAL DEVELOPMENT
WATER RESOURCE AND RELATED PROBLEMS
FEEDBACK LOOP USED TO FORMULATE PLANS IN AN ITERATIVE MANNER
PLAN BENEFITS AND COSTS AND TRADEOFFS BETWEEN SYSTEMS
A WATER RESOURCE PLAN WITH THE FOLLOWING ATTRIBUTES:
- COST EFFICIENT
- RESPONSIVE
- FLEXIBLE
- COMPREHENSIVE
- IMPLEMENTABLE

Figure 1 An Overview of Plan Formulation and Evaluation

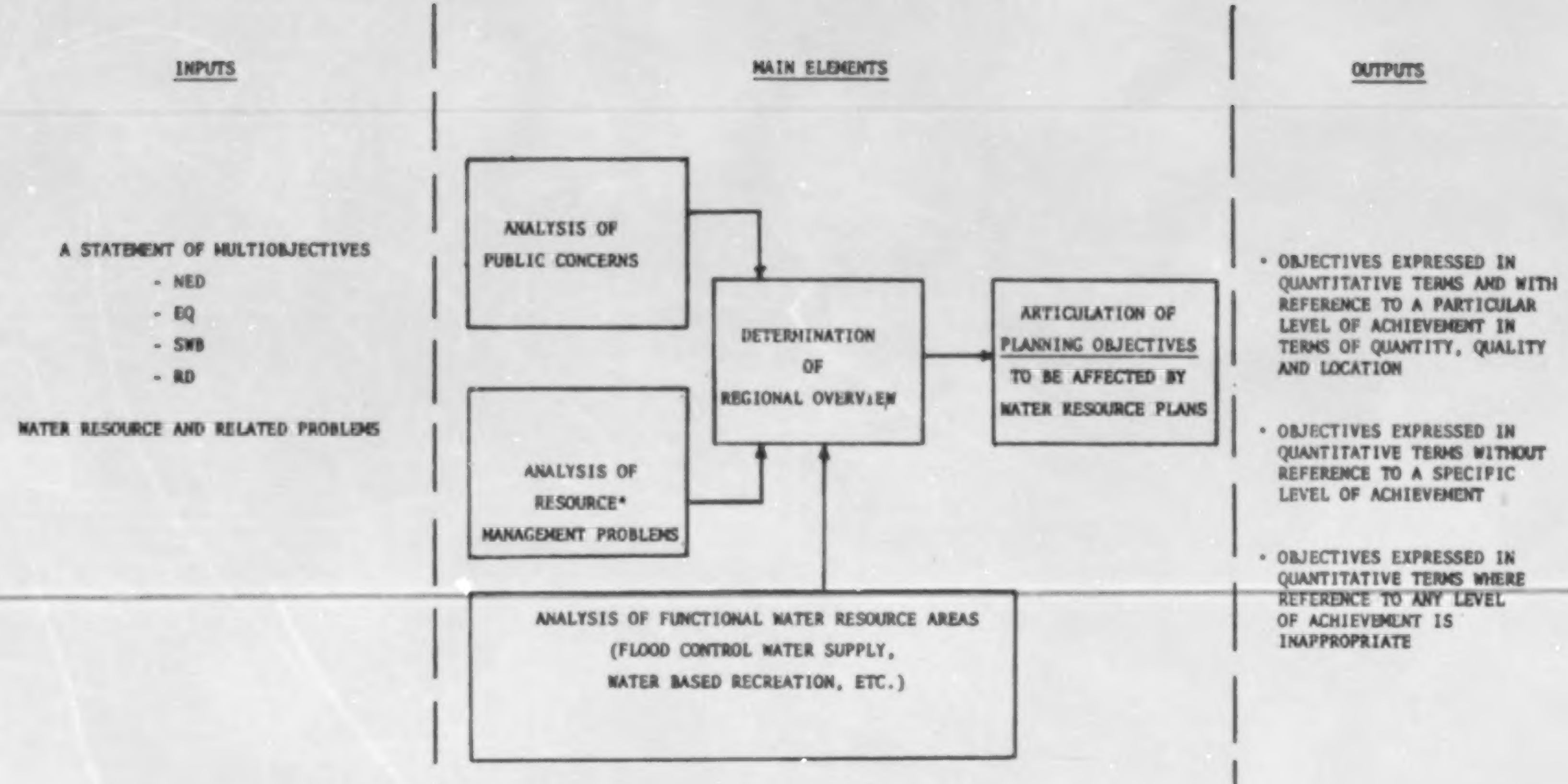

INPUTS
MAIN ELEMENTS
OUTPUTS
A STATEMENT OF MULTIOBJECTIVES
- NED
- EQ
- SWB
- RD
WATER RESOURCE AND RELATED PROBLEMS
ANALYSIS OF PUBLIC CONCERNS
ANALYSIS OF RESOURCE* MANAGEMENT PROBLEMS
DETERMINATION OF REGIONAL OVERVIEW
ARTICULATION OF PLANNING OBJECTIVES TO BE AFFECTED BY WATER RESOURCE PLANS
ANALYSIS OF FUNCTIONAL WATER RESOURCE AREAS (FLOOD CONTROL WATER SUPPLY, WATER BASED RECREATION, ETC.)
• OBJECTIVES EXPRESSED IN QUANTITATIVE TERMS AND WITH REFERENCE TO A PARTICULAR LEVEL OF ACHIEVEMENT IN TERMS OF QUANTITY, QUALITY AND LOCATION
• OBJECTIVES EXPRESSED IN QUANTITATIVE TERMS WITHOUT REFERENCE TO A SPECIFIC LEVEL OF ACHIEVEMENT
• OBJECTIVES EXPRESSED IN QUANTITATIVE TERMS WHERE REFERENCE TO ANY LEVEL OF ACHIEVEMENT IS INAPPROPRIATE

Figure 2 An Overview of Need Identification

* Resource refers to any element in the physical, chemical or biological environment that is either an input to a transformational process or that satisfies the recreational, aesthetic, cultural and scientific desires of present and future populations. Thus in addition to the traditional land, water, minerals, etc., "resource" includes examples such as: any species, tree, or open space.

a particular level of achievement in terms of quantity, quality and location, e.g., provide at least X MGD of water of quality Y at location Z; (2) those expressed in quantitative terms without reference to a specific level of achievement, but rather the desired level is expressed in terms of "as much as possible" or "as little as possible", e.g., provide as much water-based recreation as possible; and (3) those expressed in qualitative terms where reference to any level of achievement is inappropriate, e.g., preserve cultural landmarks. (In this case, planning objectives express the fact that considerations which presently do not lend themselves to quantification can still constitute an integral part of multiobjective planning.)

2. Formulation of Multiobjective Water Resource Plans. The purpose of this step is to formulate plans in accordance with the specified planning objectives and the more general multiobjectives. Such plans may be structural - e.g., construction of water supply conveyance networks, flood control reservoirs, wastewater treatment plants; the formulation includes operational, maintenance and financial considerations. The plans may also include nonstructural or institutional approaches, e.g., purchasing flood plain lands for conversion to recreational use. Thus the planner is forced to view the plan from the broad perspective of its potential to alleviate a range of needs beyond the strict water resource related problems. In this regard, the multiobjective framework requires active cooperation between the water resource planner and members of related engineering and design professions such as recreation planners, urban planners and architects in order to formulate innovative water resource systems over and above those based strictly on sound engineering principles.

3. Assessment of Impacts. The purpose of this step is to identify and measure the impacts of alternative plans, thereby providing the data base for determining the plan's performance. Input consists of changes in the availability (supply) of resources that are directly caused by the plan, e.g., quantity of surface water increased by a reservoir, wildlife stock eliminated by land

development. The output is an assessment of the qualitative and quantitative consequences of these resource changes on the economic, social and environmental domains. Although the objective is to identify all possible impacts, practical considerations require that the planner's judgment be invoked to establish a realistic search procedure, and to determine the implications that most likely will have a bearing on determining performance. Thus, assessment of impacts begins with specific measures of resource changes, subsequently fans out to capture all possible implications, and ends again with specific measurements in terms of a limited set of indicators for quantitative impacts and descriptors for qualitative impacts.

4. Evaluation. The purpose of this step is threefold: (1) determination of the significance of measured impacts; i.e., beneficial and adverse effects are identified which may lead to reformulation of plans, while insignificant effects are discarded (direction for this effort is provided by establishing planning objectives and legal requirements); (2) comparison of beneficial and adverse effects among alternative plans, which provides a basis for modifying plans to better focus on desired outputs; and (3) determination of final trade-offs among plans which provides the basis for ranking alternatives.

5. Implementation. The purpose of this step is to consider all institutional requirements necessary for successful implementation of a water resource plan, i.e., cost allocation, cost sharing, financial carrying capability of cooperating institutions, binding legal constraints, etc. Thus the planner must thoroughly examine the plan's impact on existing institutions in order to identify impediments to implementation and changes in the plan that may be required to enhance the chances for implementation.

6. Display. The purpose of this step is to present to the public, affected planning institutions and decision makers the plans, the contributions of these plans towards planning objectives, the plan's unanticipated beneficial and adverse effects, and the trade-offs among alternatives. In addition, this step displays

requirements in terms of cost and institutional arrangements for financing, operation and maintenance. This display of results provides the basis for decision making with respect to recommending any alternative for action by Federal, State or local governments.

B. The Impact Assessment Process

The following delineates the scope of the impact assessment process and provides a general structure.

1. The Plan as a Source of Impacts

A water resource plan induces an infinite number of changes through a chain of cause-effect relationships. For example, improved water quality planning may result in a quantitative change in the amount of mercury discharged into a watercourse; this immediate change is considered a primary impact. The primary impact, in turn, sets off a series of effects that is theoretically unlimited: reduced mercury content permits utilization of the watercourse by a number of industries previously precluded, or the mercury compounded in fish is reduced which in turn reduces the health hazard due to mercury poisoning, which has implications with respect to the community's image because public fears have been allayed, and so on.

Impact assessment is initiated by systematically representing the water resource plan in order to identify primary impact sources, and subsequently, to measure the impacts in terms of basic units reflecting changes in quantity, quality and location of resources. Although no general methodology is available, a useful device is to consider the plan in terms of outputs and inputs needed to produce these outputs. For example, Figure 3 presents a simplified representation of a regional wastewater management (WWM) plan which provides a conceptual starting point for identification of primary impact sources. However, more detail is required to carry out the measurement of primary impacts and to structure the search for implications. Thus, the plan is further delineated and primary impact sources are classified as they relate to physical aspects of the plan. Specific regional characteristics and planning objectives are used to eatablish direction for, and priorities in, the identification and measurement of implications. For example, for a region deficient in water supply, the potential of improved water quality as an alternative supply source is significant; for a region deficient in water-based recreation, emphasis is placed on using high quality effluent for recreational purposes.

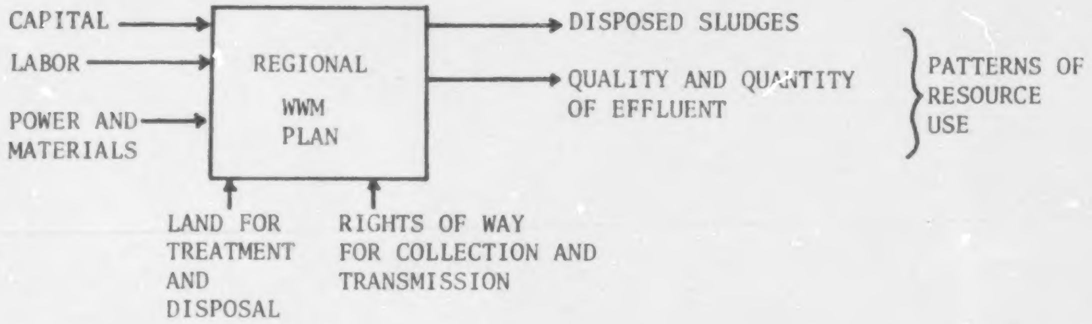

CAPITAL
LABOR
POWER AND MATERIALS
REGIONAL WWM PLAN
DISPOSED SLUDGES
QUALITY AND QUANTITY OF EFFLUENT
PATTERNS OF RESOURCE USE
LAND FOR TREATMENT AND DISPOSAL
RIGHTS OF WAY FOR COLLECTION AND TRANSMISSION

Figure 3 Outputs and Requirements of a Water Quality Plan

2. General Structure of Impact Assessment

Up to this point, the discussion has centered around primary impact sources. This subsection focuses on the process itself. Figure 4 shows a two-phase delineation of impact assessment. In the first phase, impact identification, primary impacts are identified, measured in terms of changes in the physical/chemical/biological environment, and analyzed in terms of implication on the economic, social and environmental domains. At this stage, no in-depth measurement of the entire cause-effect chain initiated by such impacts is attempted. In the second phase, impact measurement, primary impacts and their implications are transformed into a system of indicators and descriptors which adequately represent significant positive and negative economic, social and environmental changes. These indicators and descriptors are devised so as to provide a set of aggregate measures representing the range of impacts covered by multiobjectives in general and planning objectives in particular. Thus, if Y_i is an indicator,

$$Y_i = f(x_1, x_2, \ldots, x_n) \tag{1}$$

where x_i is an independent variable representing possible implications which are functionally related to the indicator Y_i. When this functional

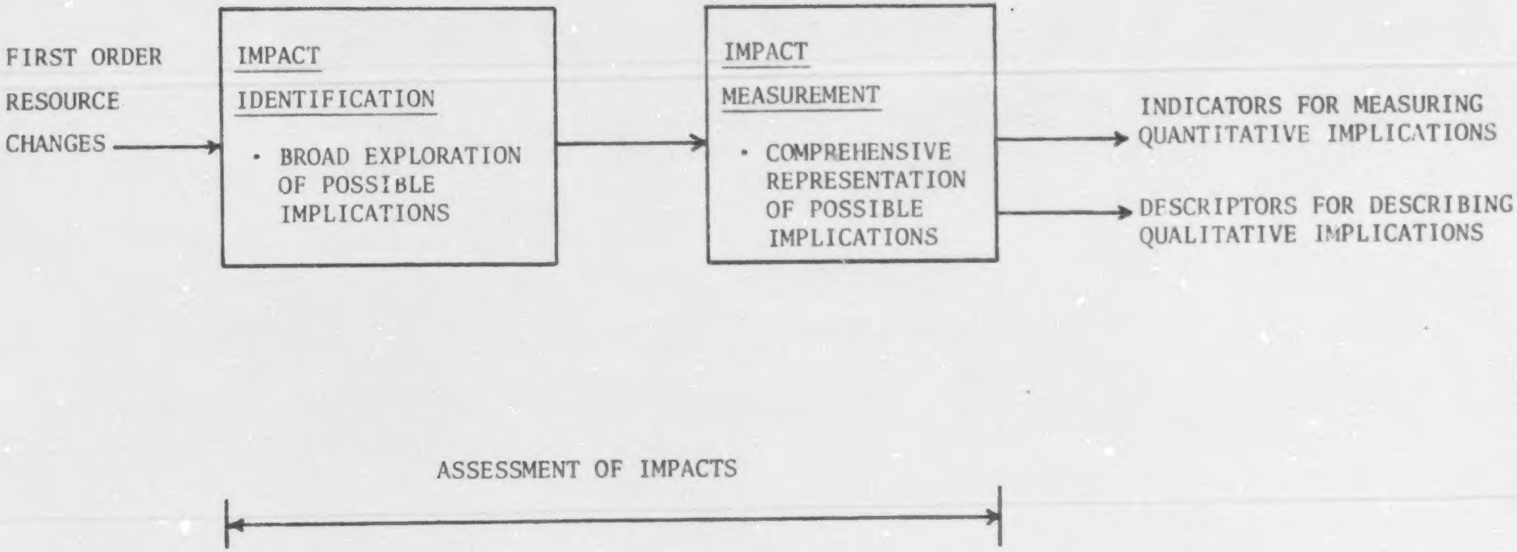

FIRST ORDER
RESOURCE
CHANGES
IMPACT
IDENTIFICATION
• BROAD EXPLORATION OF POSSIBLE IMPLICATIONS
IMPACT
MEASUREMENT
• COMPREHENSIVE REPRESENTATION OF POSSIBLE IMPLICATIONS
INDICATORS FOR MEASURING QUANTITATIVE IMPLICATIONS
DESCRIPTORS FOR DESCRIBING QUALITATIVE IMPLICATIONS
ASSESSMENT OF IMPACTS

Figure 4 An Overview of Assessment of Impacts

relationship is known, the significant implications are recognized as those which substantially effect the value of Y_i.

Impact assessment is separated from final evaluation by a synthesis of information necessary to assess a plan's contributions towards planning objectives formulated in the same terms. If a composite representation is not possible, individual impacts are related to planning objectives stated in the same terms. Therefore, if composite measures cannot be derived in the measurement process, the consequence for subsequent evaluation is that the number of planning objectives increases and the trade-off process becomes more difficult.

The following statements accentuate the distinction between the two phases of impact assessment:

- Identification of impacts refers primarily to recognition of possible implication; measurement refers to determination of a composite set of indicators and descriptors.
- In identification, relatively few primary impacts are measured while many implications are identified; in measurement, all indicators are measured and all descriptors are adequately specified.
- The function of identification is mainly exploratory; the function of measurement is analysis of relationships.
- Identification, being exploratory, is less amenable to structured analysis; a comprehensive list suggesting possible impacts is the extent to which the planner can be assisted. Measurement is amenable to a structured approach; a generally applicable system of indicators and descriptors based on multiobjectives can be devised to assist the planner.

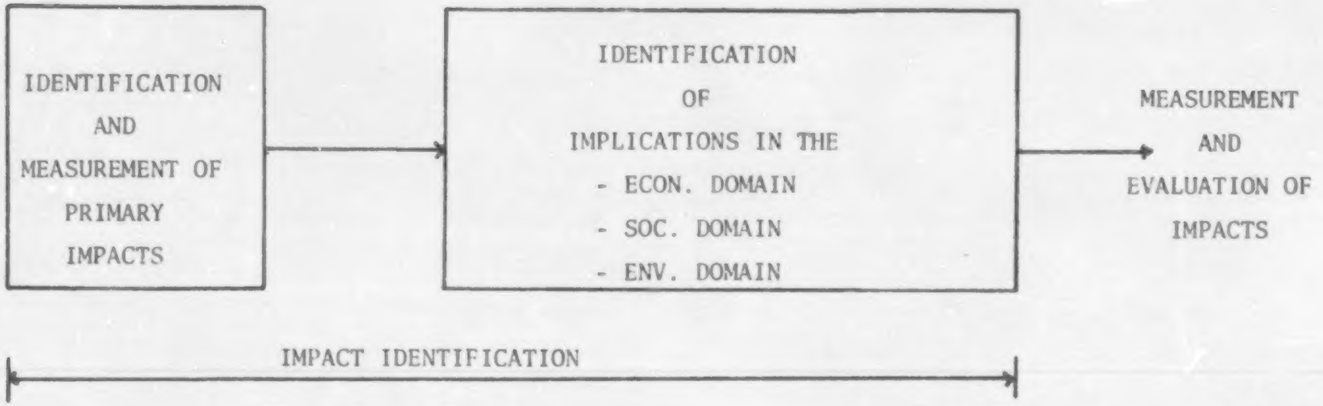
For analysis purposes, the remaining task is to further narrow down the transformation that takes place from primary impacts to measured implications. To this end, it is necessary to identify a mechanism which relates primary impacts in a direct way to their consequences represented in a system of accounts.

Figure 5 illustrates this mechanism. In contrast to the simplified impact identification presented before, it is postulated that the transformation of primary impacts into a system of accounts occurs on the basis of either environmental changes or activity changes.

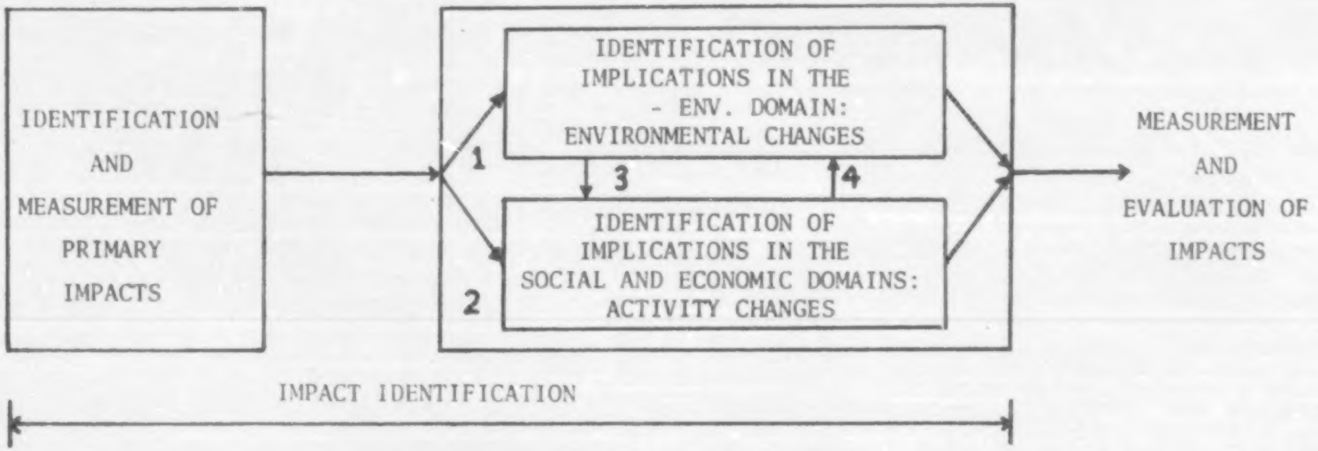
- An Environmental Change is defined as a transformation that causes the implication to be measured and evaluated within the environmental domain; that is, no attempt is made to relate such change to human activity. Environmental changes are discussed and classified under the environmental account.
- An Activity Change is defined as a transformation that causes the implication to be measured and evaluated within the economic and social domains of man's activity and represented in the remaining three accounts.

Environmental changes can result as a direct consequence of primary impacts or they can result as a consequence of higher-order changes throughout the chain of implications. The first type of changes are indicated in Figure 5 by numbers 1 and 2; higher-order changes by numbers 3 and 4. This distinction between types of changes is used in order to focus on changes resulting from water resource planning that are not necessarily or explicitly planned for. For example, if improved water resource planning results in new recreation opportunities - a direct consequence of primary impacts - appreciable pollution may be created by litter and garbage disposal problems of recreationers which, in turn, affects environmental quality - a higher-order change. Any significant higher-order environmental change should be included in the analysis of the plan because frequently these changes represent a cost; in the above case, the cost of cleaning up the environment.

In conclusion, assessment of impacts resulting from water resources development involves identification of primary impact sources, measurement of primary impacts and transformation of primary impacts through environmental and activity changes into measured indicators and descriptors encompassing the economic, social and environmental domains and represented in a four-account system.


IDENTIFICATION AND MEASUREMENT OF PRIMARY IMPACTS
IDENTIFICATION OF IMPLICATIONS IN THE
- ECON. DOMAIN
- SOC. DOMAIN
- ENV. DOMAIN
MEASUREMENT AND EVALUATION OF IMPACTS
IMPACT IDENTIFICATION

(A) PREVIOUSLY PROPOSED STRUCTURE


IDENTIFICATION AND MEASUREMENT OF PRIMARY IMPACTS
IDENTIFICATION OF IMPLICATIONS IN THE - ENV. DOMAIN: ENVIRONMENTAL CHANGES
IDENTIFICATION OF IMPLICATIONS IN THE SOCIAL AND ECONOMIC DOMAINS: ACTIVITY CHANGES
1
2
3
4
MEASUREMENT AND EVALUATION OF IMPACTS
IMPACT IDENTIFICATION

(B) TRANSFORMATION MECHANISM

Figure 5 Impact Identification

C. Measurement of RD Effects

Extending the framework presented in the previous section to the assessment of RD effects yields Figure 6. It is shown that measurement is preceeded by the identification phase. Inputs to this phase are:

- Text of the Principles and Standards indicating the range of effects which the planner should take into consideration.
- Primary Impacts associated with the actual plan developed by the planner.
- A set of concerns regarding regional development in terms of the economic, social and environmental viability of the region(s) under consideration, for which there exist the expectation that they can be related to the primary impacts generated by the plan.

The identification phase will establish which of the RD effects listed in the Principles and Standards will in fact be significant enough to be subsequently measured. The key consideration is that the link between primary impacts associated with a plan and regional development concerns expected to be relevant in the particular planning context be traced to provide a firm basis for the subsequent measurement phase. It is noted that the above forms a departure from the traditional approach requiring that for each plan all effects listed in the Principles and Standards be investigated.

As indicated in the previous section the transformation from primary impacts towards measured effects takes place through either environmental changes or activity changes. The problems in the identification phase therefore reduce towards providing, largely qualitative, answers to the following two generic questions:

- What aspects of activity changes caused by the primary impacts relate to RD concerns? For example: will the primary impacts caused by a flood control implementation study (e.g., the changes in the availibility of land and/or water in the region) cause the resulting activity changes to have economic implications affecting regional income? Normally and for relatively small studies this

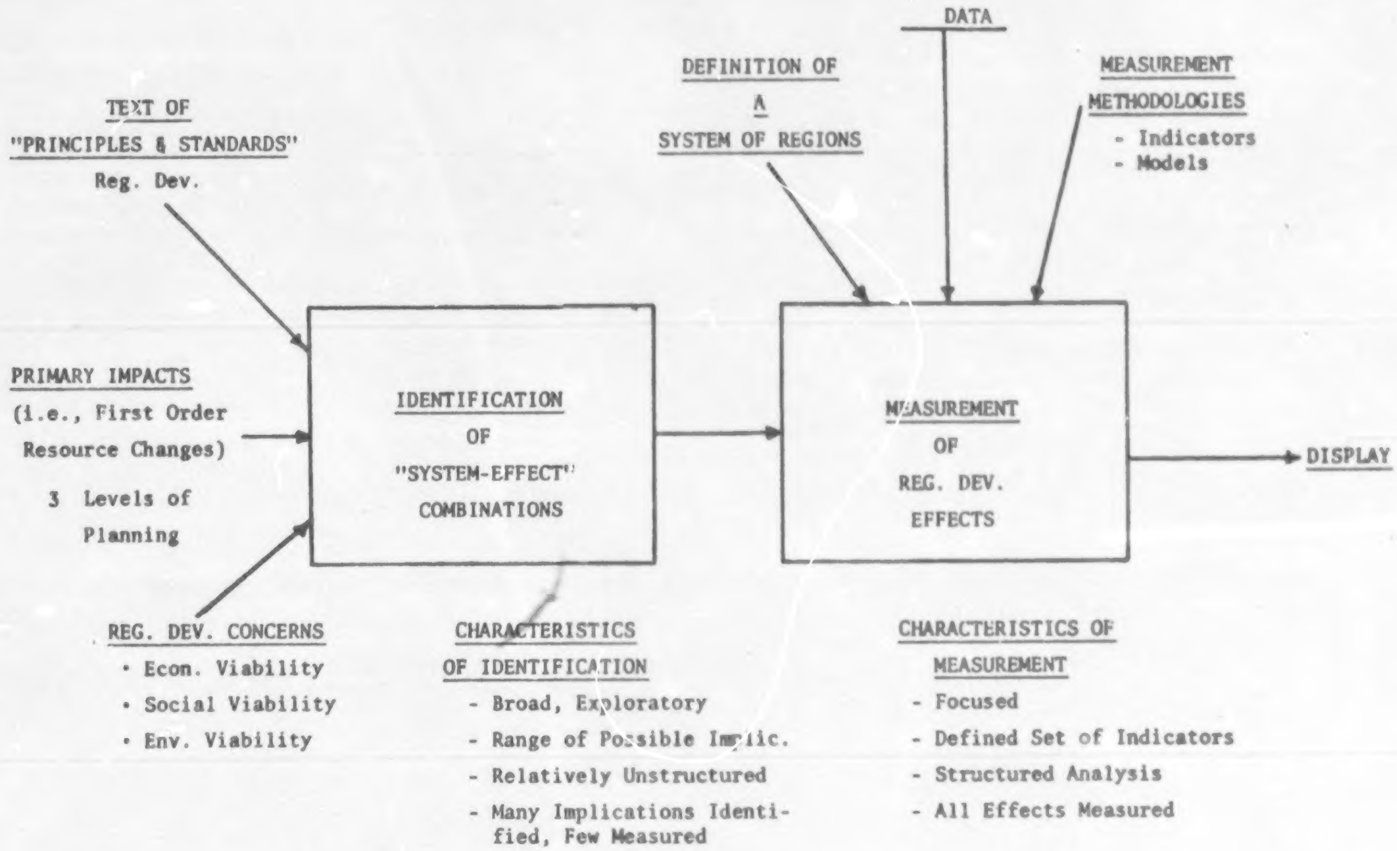


Figure 6 Assessment of Regional Development Impacts

is not the case. However, the social viability of the region may be considerably enhanced as a result of the activity changes. Consequently the analysis focuses on measuring the link between the primary impacts associated with the flood control project and the social implications with the activity changes.

- What environmental changes caused by the primary impacts relate to RD concerns? For example: will the primary impacts of a large regional system of reservoirs (e.g., the change in aquatic and terrestrial habitats) cause environmental changes detrimental to the environmental viability of the region?

Once it is established what system-effect combinations are to be measured the analysis takes a different course and becomes "specifics" oriented. Figure 6 indicates the key considerations for measurement: (1) definition of a system of regions; (2) data availability; and (3) measurement methodologies. With respect to the latter this entails the existence of a functional relationship, similar to the general form presented in equation (1), for the indicators selected to represent the subject system-effect combination. For example, if regional stability is to be associated with the induced industrial and commercial development (activity changes!) expected to result from a water resource project, then the sequence of steps is:

- Define the region(s).
- Identify and measure primary impacts for the region(s).
- Identify and measure changes in industrial and commercial activity in the region (e.g., projected output changes).
- Select indicator for regional stability.
- Relate quantitatively the above indicator to activity changes.

It is clear that in the execution of each step of this sequence the availability of data plays a key role.

Measurement Issues

A. Introduction

Previous sections have emphasized the intent of RD measurement and its place and function in the planning process. Actual execution of the RD measurement phase is a complex task. The purpose of this section is to review the major issues facing the planner/evaluator in performing this task and to point towards efforts that have been or are undertaken to resolve these issues. At the outset, however, it should be noted that most research on the measurement of RD effects is still in a very preliminary state and bedeviled by rather large conceptual and data problems. Needless to say that in this account area one cannot speak of an already integrated approach. Rather, efforts are scattered and diffused.

The key problem in structuring RD measurement relates to the many relationships that exist among RD effects. Figure 7 is a simplified representation of these relationships primarily for illustrative purposes as contrasted to presenting an accurate description of all interactions. It is shown that a primary impact resulting from a water resource development plan may affect the output and/or location of water-using activities within the region which in turn may affect the output and/or location of other economic activities in the region. Depending on the definitions of regional boundaries the above changes may lead to changes in activities in other regions which then may have an influence on the activities in the study region and so on. Central to RD measurement, however, is to anticipate the changes in output and/or location of activities in all regions.

The above changes provide the necessary information to measure changes in regional economic stability by analyzing the change in the region's economic base, changes in employment and changes in the distribution of people within the region, changes in aggregate regional income and in changes in per capita regional income. It is these latter changes that are of most interest to decision makers since they relate directly to policy making. However, to calculate such changes the planner/evaluator should have at his disposal the "tools" to anticipate changes in output and/or location of regional economic activities.

The major issues in RD measurement that can be inferred from Figure 7 are as follows:

- Definition of Regions.
- Interrelationship between Regions.
- Tools for measurements.
- Regional Baseline Projections.
- RD measurements to display regional viability.

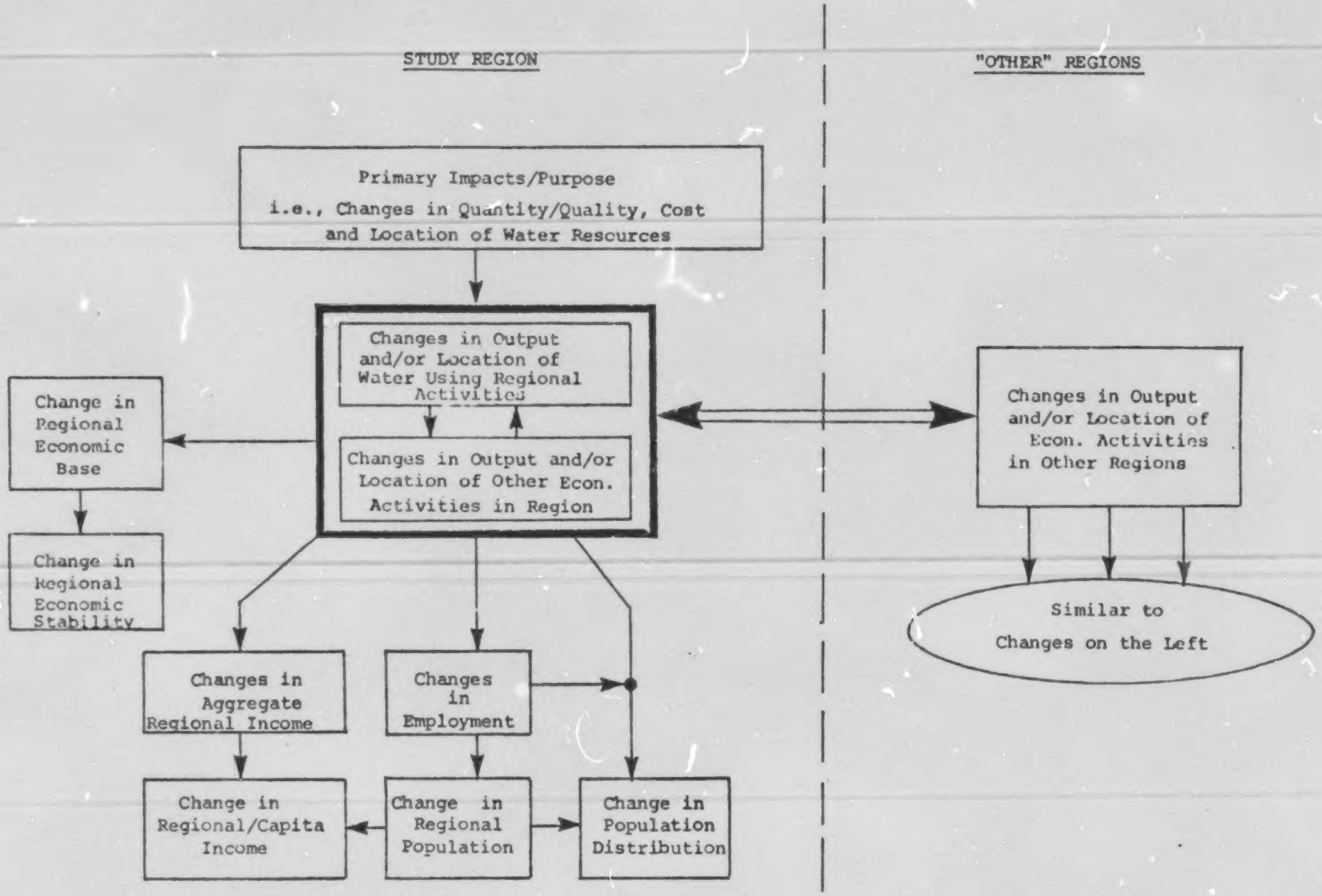

STUDY REGION
"OTHER" REGIONS
Primary Impacts/Purpose i.e., Changes in Quantity/Quality, Cost and Location of Water Resources
Changes in Output and/or Location of Water Using Regional Activities
Changes in Output and/or Location of Other Econ. Activities in Region
Change in Regional Economic Base
Change in Regional Economic Stability
Changes in Aggregate Regional Income
Changes in Employment
Change in Regional/Capita Income
Change in Regional Population
Change in Population Distribution
Changes in Output and/or Location of Econ. Activities in Other Regions
Similar to Changes on the Left

Figure 7 Simplified Representation of the Relationships Between RD Effects

B. Definition of Regions

Probably one of the most fundamental and heaviest debated issues relates to what to consider as boundaries of a region. In reference 3 Geyer states:

> "Traditionally three different approaches have been used in defining regions. The first stresses homogeneity with respect to some one or combination of physical, economic social or other characteristics; the second emphasizes so-called nodality or polarization, usually around some central urban place; and the third is programming- or policy-oriented concerned mainly with administrative coherence or identity between the area being studied and available political institutions for effectuating policy decisions. Naturally enough, regional definitions as established in practice often represent a compromise between these different pure types. In particular, availability and limitations of data can and do dictate departures from "ideal type" definitions in many situations.
>
> Strictly speaking, moreover, the three traditional definitions of regional type are not mutually exclusive. In fact, all regional classification schemes are simply variations on the homogeneity criterion and it is somewhat misleading to suggest otherwise. The only real question is what kind of homogeneity is sought."

Antle and Struyk argue that for a particular project several regions may be defined, dependent on scale and purpose of a water resource project. They offer the following definitions.

1. "Project region: the area within which increased water-related activity and/or the direct consequences of such activity occurs.
2. OBE region: the area within which the economic activity of the project region without the project is focused. For convenience, more than one region defined by OBE may be aggregated.
3. Displacement region: the area from which the project is anticipated to draw labor force, jobs, or visitors to the project area. This is likewise the area in which substitutions of consumption or production will occur as the project regions draw income and people to the project region.
4. System of regions: a system of regions closing on the entire area of the continental U.S. including the region defined in (2); this set of regions is the same for all project evaluations, save for the project region itself" (Reference 4).

While the above discussion underscores a number of points, the definition of regions in reality is by necessity a compromise. Probably, the most important consideration in regional definition for empirical purposes has been data availability. The vast majority of statistical information is collected on the basis of political jurisdiction. In this regard counties are the smallest possible units for which data is available. Regions are therefore formed as an aggregate of counties where the only freedom is in the number of counties that constitute the region. The Office of Business Economics has used the nodality criterion stated above to divide the whole U.S. in sets of counties called OBE regions. For the water resource planner this however has not resolved the problem because the OBE region might still be too large to differentiate the effects of the project on a geographic basis. In conclusion, definition of region is most likely to be resolved on a project by project basis and in a rather pragmatic sense.

C. Interrelationships Between Regions

As a mere consequence of focusing on the economic development of individual regions the analytical problem of interrelationships between regions has been introduced into the assessment. There is sufficient empirical evidence that these relationships can be important for project evaluation. For example, Tolley estimates in Reference 5 that one in twenty low income farm workers in the Southeastern United States was displaced because of the billion dollar federal reclamation development in the Southwest.

Modeling the interrelationships between regions requires first of all that the changes in output and/or location of water using activities can be traced throughout the economy of the affected region; the way in which these changes multiply throughout the economy of the region. This calls for an interindustry analysis. Second, since some of the changes (i.e., increased demand for activity inputs) may be satisfied by output expansions in other regions it is necessary to have an interregional interindustry analysis. It is noted that the above indicates the types of analysis and not the tools used. With respect to the latter very few attempts have been made to develop such tools. One example is contained in Reference 6 which was applied to determine the effects of a project in a six county reservoir area in Appalachia on the rest of Appalachia and the rest of the

United States. General applicability of this model is not only limited by the large data requirements but moreover by the extreme complexity and intransparency of the model and its assumption.

D. Tools for Measurement

The tools aimed at determining changes in regional economic activity traditionally are a part of the regional economics discipline and belong to the following three categories:

- Input-Output Models. This type of model provides in matrix form the static relationships between the inputs and outputs of all industries within a regional economy. Key data elements in the analysis are the technical coefficients which determine per unit of output in each industry; and how much input is required from other industries to produce this unit of output. Frequently, application of such models is **severely limited by data availablity.**
- Multiplier Models. These models are usually connected with the notion of an economic base. The first step is to define activities as being exogeneous or determined outside of the region under analysis. The economic base of the region is then that group of the industries primarily engaged in exporting from the region under analysis to other regions. An empirical multiplier is determined by observing the historical relationship between this export activity and total economic activity in the region. This empirical multiplier is then applied to estimates of the economic base to forecast total economic activity.
- Comparative Cost Models. These models are especially applicable in analyzing the location of economic activities. The comparisons normally are made strictly between regions on the apparent assumption of some sort of interregional market equilibrium existing in factor prices. The procedure usually involves doing a set of cost comparisons for supplying certain products to specified markets from the given region as compared with alternative sources of supply for these same markets. The first step in the analysis is to look at factor or input costs that are particularly important or almost necessarily different between regions; thus transport costs are almost always analyzed and usually labor costs or costs

of a peculiarly important input are also analyzed. For an illustrative and brief description of these models see Chapter 2 of Reference 7.

E. Regional Baseline Projections

Projections of economic activity in the region under analysis without the project are an essential element in the planning process in general and in the measurement phase in particular. They serve three major uses. First, a primary use is in the assessment of future demands for water and related land resources. Second, they can be used as indicators of potential economic problems in an area. Third, they provide a benchmark framework for evaluation purposes. A first step in calculating these projections is to accurately define what this without condition consists of. This is by no means a trivial problem because it entails the specification of what is most likely to occur without the plan. Realizing that planning efforts other than water resource planning also may influence economic activity, projecting a without condition essentially involves projecting the results of such efforts.

As a first step towards determining baseline projections OBERS projections presently form the most logical starting point. These projections are made for the Nation, Bureau of Economic Analysis (BEA) economic areas, water resources regions and subareas, States, standard metropolitan statistical areas (SMSA's) and the non-SMSA portions of economic areas and water subareas. Included are projections of population, personal income, employment and earnings of persons, by industry. The projections cover 1980, 1985, 1990, 2000 and 2020. Also included are projections of land use by broad categories for the same 50 year period but with fewer intervening years covered. The historical information from which the projections were derived is included in essentially the same geographic detail as the projections. OBERS projections provide the best estimate of what can be expected if historical trends continue in the future. Any identifiable long-term secular trends are implicitly included in the projections. The projections are in no sense a goal, an assigned share, or a constraint on a region's economic activity. The OBERS projections were made in two major steps. First, the national economy was projected in industrial detail. Secondly, these projected national totals were distributed regionally in accordance with projected trends in the regional distribution of economic activities.

If properly adjusted, OBERS projections may provide the data base to derive the without condition. In doing so, the following three important problems have to be recognized and resolved:

- First, study areas chosen for water resource planning may not coincide with the geographic areas for which OBERS projections exist. As a result aggregation and/or disaggregation of projections is necessary which cannot always be accomplished in a simple manner. For example, in splitting an area for which projections exist in two parts commuting patterns may be cut separating place of residence and place of work. This results in a distortion of the calculated per capita income unless an adjustment is made in the per capita income so as to make it match the population data on a place of residence basis.
- Second, the basic characteristic of the projections is that it provides the best estimate of what can be expected if historical trends continue in the future. Thus, OBERS projections are a function of past economic trends and these have been influenced to some degree by water resource development. The level of resource development assumed in the projections cannot be explicitly dated, but is implicitly assumed to follow historical trends. Consequently, projections of both the available supply of and demand for water and related land resources, and an analysis of the adequacy of the resources are required. To the extent that additional resource development is required if OBERS projections are to materialize, they present a "with" condition. To the extent that the projections can materialize without additional development they represent a "without" condition. The problem is more complicated where a project is expected to improve the economic efficiency of an area, and economic projections are used to evaluate the problem. The question if the project was or was not assumed is not easily answered. This would be much simpler if future resource development associated with projections of economic activity could be specified explicitly.

As it is, a comparison with historical water resource development in the area may give an indication of what the proper assumption should be.

- Third, in general land resources and local policy constraints have so far not been explicitly included in disaggregation procedures. These constraints are expected to be progressively more important for smaller geographic areas.

F. RD Measurements to Display Regional Viability

As indicated in the introduction to this Section the most important information in measuring RD effects is the projection of changes in output and/or location of economic activities affected by the water resource plan. They provide in a relatively straightforward manner the resulting changes in employment, the distribution of people, and per capita income. With respect to employment this will entail an additional assumption on the anticipated productivity levels by industry. Given the change in output and productivity in each industry the change in employment can be assessed.

Population distribution can be assessed on the basis of employment projections and location of economic projections. In order to account for the non-working force, total population is stratified in a labor pool, pre-labor pool and post-labor pool. Population in the labor pool is assessed based on the employment distribution while the remaining categories can be related to the labor pool and other characteristics of the area such as age distribution by area. Finally, the importance of the indicators (e.g., population distribution) resulting from the basic economic models is in the comparison with the regional baseline to display the achievements of the plan.

References

1. "Water and Related Land Resources; Establishment of Principles and Standards for Planning," Federal Register, Vol. 38, No. 174, September 1973, pp. 24778-24869.

2. A.M. Freeman III, R.H. Haveman; "Benefit Cost Analysis and Multiple Objectives: Current Issues in Water Resources Planning," Water Resources Research Vol. 6, No. 6, December 1970.

3. John R. Meyer, "Regional Economics: A Survey" in Surveys of Economic Theory, Vol. II, St. Martin's Press, New York, 1966.

4. L.G. Antle, R.J. Struyk; "Regionalization in the Context of Multi-objective Planning and Evaluation," Center for Economic Studies, Institute for Water Resources, U.S. Army Corps of Engineers, October 1970.

5. G.S. Tolley, "Reclamation's Influence on the Rest of Agriculture," Land Economics, Vol. 35, No. 2, May 1959.

6. "Development Benefits of Water Resource Investments," Edited by Charles L. Leven, Washington University, St. Louis, Missouri, report prepared for IWR, U.S. Army Corps of Engineers, November 1969.

7. W. Isard, Ecologic - Economic Analysis for Regional Development, The Free Press, New York, 1972.

8. "Estimation of First Round and Selected Subsequent Income Effects of Water Resources Investments," Edited by George S. Tolley, Department of Economics, University of Chicago; A report prepared for IWR, U.S. Army Corps of Engineers; February 1970.

ECONOMIC MODELS FOR THE MEASUREMENT OF REGIONAL INCOME AND EMPLOYMENT EFFECTS

Henry L. DeGraff
Bureau of Economic Analysis, U.S. Department of Commerce
Washington, D.C. 20230

The Bureau of Economic Analysis is developing a National-Regional Impact Evaluation System (NRIES) which measures both the national economic efficiency and the regional redistributive effects of public investments. This system is designed to trace income effects, redistributions of industrial activities, and population movements over a detailed regional delineation of the Nation over time. The underlying income accounting procedures incorporated in the NRIES permit consistent comparisons of the national and regional economies with and without a public investment over the life of the project. The system is constrained such that the generation of industrial activity stemming from the public investment in one region is balanced by explicit reductions or foregone expansions of similar industrial activity in other regions. Additionally, the regional specification of the project labor force in correspondence with employment in the NRIES, reveals at each point in time the existence of otherwise unemployed labor that may be captured as a result of one or more of the regional redistributions. If captured, the level of national income is increased by the net addition of the earnings of these newly employed resources.

For the most part the BEA measurement effort is not directed toward estimation of the primary income benefits attributable to a project. Calculation of the primary income benefits, as in traditional B/C analysis, remains the responsibility of the agency proposing the project. However, in order to be able to serve agencies which do not have the capability of estimating the primary benefits of a program, BEA is also working on primary effects model for manufacturing industries which are sensitive to access to markets and to sources of supply. Calculations of primary benefits are required as inputs to the NRIES, which specifies the regional redistributive and any net national secondary effects derived through utilizing otherwise under- or unemployed labor. The outcomes yielded by the submodels of the NRIES may serve, however, as feasibility tests for the initial estimates of primary income benefits and for further refinement of these estimates.

The NRIES has been designed to be specifically responsive to the benefit accounts incorporated in the Principles and Standards of the Water Resources Council. However, use is not restricted to these accounts. Indeed, the system offers flexibility both with respect to the type of public investment (water resource, pollution abatement, etc.) and the associated benefit accounts, and to the level of regional aggregation necessary in measuring the redistributions and secondary benefits.

Conceptual Basis of the National-Regional Impact Evaluation System

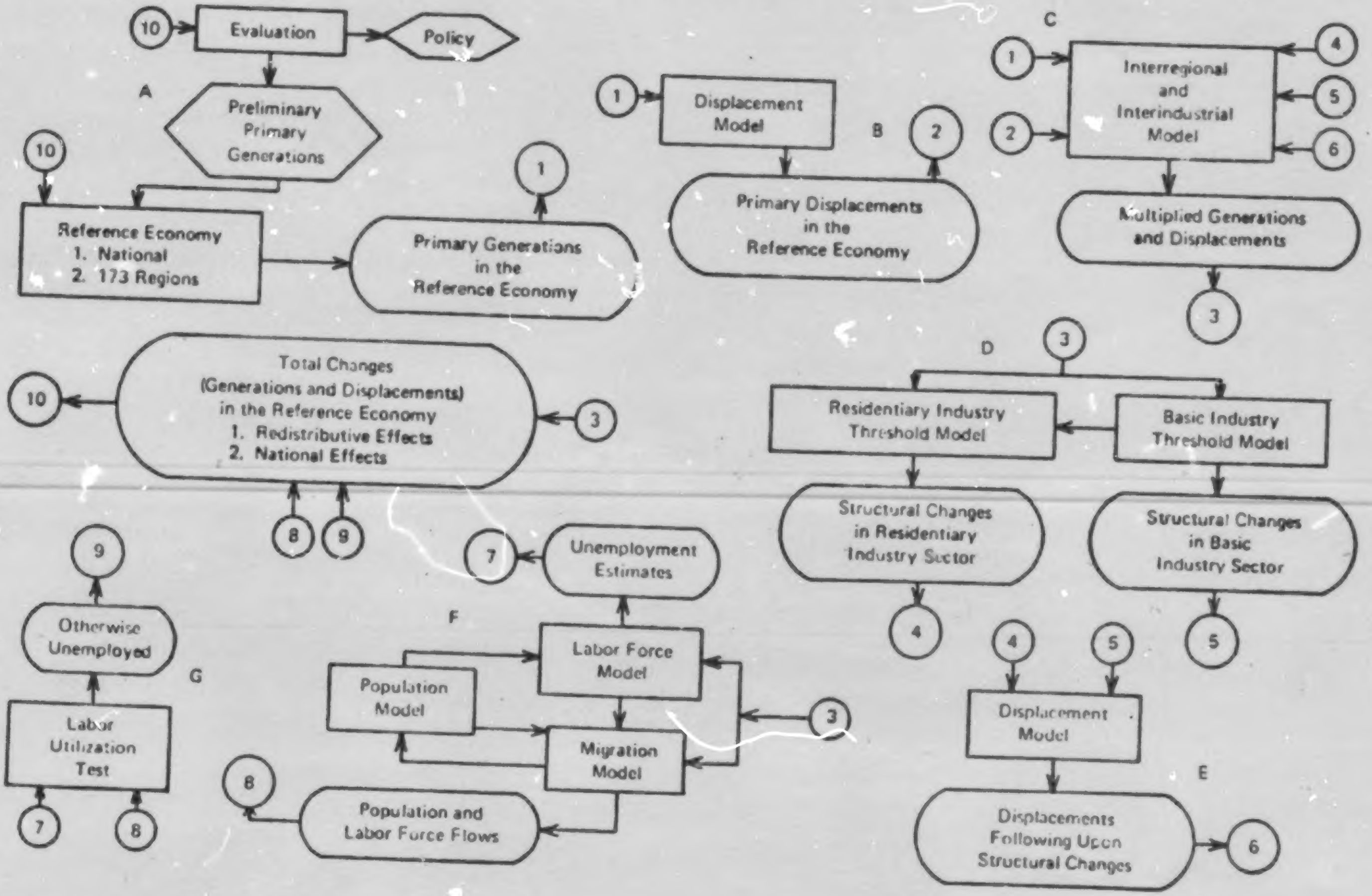
National income benefits can be attributed to public investments only insofar as increased productivity per unit of input and/or increased utilization of otherwise resources may obtain. Too often regional models are brought to bear in evaluating public investments in which regional redistributions are perceived in total as National benefits. The reaction against improper discrimination between regional redistributions and net benefits has been widespread, and often overshoots its mark. Thus, the tendency to argue that secondary benefits completely wash out at the national level is opposite to the attribution that all regional secondary benefits constitute national benefits. This polarity of views in practice results from the inability heretofore to measure the incidence of displacement and to assess the extent to which displacement may offset generation. And it is this inability which the BEA System seeks to remedy.

The system of models being developed by BEA discriminates between regional redistributions and secondary net national benefits by identifying the geographic location of total generation and displacement effects. For impact analysis, there is no valid distinction between primary and secondary effects. Rather, the total generation and displacement effects determine both the redistributions and the net national effects. The purpose of distinguishing between primary and secondary effects is to delimit the various agencies' responsibilities and expertise with respect to measuring each of the partial effects.

The BEA System is designed to trace primary displacements and both secondary generation and displacements, once given estimates of primary generation by the agency proposing the project. The latter serve as inputs to the NRIES in the form of estimates of increases in economic activities by immediate users of the project outputs in areas directly advantaged by the proposed investment. The impacts are first traced as offsetting deviations from a conventionally defined full employment reference economy is that with and without project comparisons may be made on a basis of other things remaining equal. In addition, reading from a common full employment reference economy permits alternative regions. Deviations from the reference economy consist of the direct, indirect and induced effects attributable to the public investment, in terms of the increases in economic activities in some areas and decreases (or foregone expansions) in others. Redistributions of economic activity, net employment and associated income effects are measured by several sub-models of the NRIES: (See Figure 1)

1. Initially, a regional specific industry displacement model determines which regions will be competitively disadvantaged offsetting the increases in areas benefited by the public investment.
2. An interindustry multiplier model assesses the secondary effects on both competitively advantaged and disadvantaged areas. These effects include the induced expansions and contractions on both suppliers or intermediate goods and services to directly affected industries and suppliers of consumer goods and services to the affected regional populations.
3. Industry location threshold models identify any further induced redistributions of economic activity stemming from changes in the size and industrial composition of areas.
4. Associated with changes in economic activity, models detailing population, labor force and migration balance regional employment opportunities and labor force.

FIGURE 1 —National-Regional Impact Evaluation System



10
Evaluation
Policy
A
Preliminary Primary Generations
10
Reference Economy
1. National
2. 173 Regions
Primary Generations in the Reference Economy
1
1
Displacement Model
B
2
Primary Displacements in the Reference Economy
C
1
2
Interregional and Interindustrial Model
4
5
6
Multiplied Generations and Displacements
3
10
Total Changes (Generations and Displacements) in the Reference Economy
1. Redistributive Effects
2. National Effects
3
8
9
D
3
Residentiary Industry Threshold Model
Basic Industry Threshold Model
Structural Changes in Residentiary Industry Sector
Structural Changes in Basic Industry Sector
4
5
9
Otherwise Unemployed
G
Labor Utilization Test
7
8
7
Unemployment Estimates
F
Labor Force Model
Population Model
Migration Model
3
8
Population and Labor Force Flows
4
5
Displacement Model
E
Displacements Following Upon Structural Changes
6

NOTE: If outputs 4 or 5 are unequal to zero, then D and E return to C before engaging F.

The employment estimates calculated by the interindustry multiplier and industry location thresholds models and redistributed by the displacement model together with the labor force estimates calculated in the demographic model yield the estimates of regional unemployment at each point in the projection period.

The unemployment rate estimates are required as inputs into a labor force utilization test which compares the difference between the labor market conditions in all regions of the Nation with and without the proposed project over its lifetime. The labor force utilization test separates out labor force transfers consisting of management and skilled personnel required for the new or expanded enterprises in the competitively advantaged areas, and other migrants into or out of the area who locate wherever job opportunities exist and thus would be otherwise employed in the reference economy. Both categories are treated as redistributions that neither add to nor subtract from preexisting national access to labor resources.

The utilization of the residual, otherwise unemployed resident labor force is then subjected to a test for net national employment effects. Here rates of unemployment in the generation area (competitively advantaged by project) and in displacement areas (competitively disadvantaged by project) are compared. A net displacement relationship evaluates the reemployment potential of released workers in the areas of displacement so as to subtract out from gross displacement those who are likely to become reemployed during the appropriate time interval. The higher the unemployment rates in the generation areas relative to those in the displacement areas, the smaller is the value of net displacement (the greater are the net national employment effects). The rationale for this relationship is that areas with persistent high unemployment rates (even in the face of substantial net outmigration) are not as well integrated into the national economy as are areas with relatively low unemployment rates. For example, the shift of the textile industry from the New England and Mid Atlantic States to the Southeastern States was accompanied by unemployment of textile workers in the former two displacement regions. Thus new employment opportunities were provided in the South East which may not have existed otherwise, while the disemployed industrially experienced workforce, particularly in the bigger cities in the displacement regions was generally successful in finding new employment opportunities in their regions although the process was not instantaneous.

In summary, the NRIES traces the direct, indirect and induced redistributions of economic activity and population, and then consistently nets out redistributions to evaluate the net increase in national utilization of otherwise unemployed labor force, attributable to the project:

1. Gross Generation - Gross Displacement = Regional Effects,
2. Regional Employment Effects - Transferred Skilled and Managerial Personnel - Other Migrated Labor Force = Utilization of Resident Unemployed Labor Force,
3. Utilization of Resident Unemployed Labor Force - Reemployment of Disemployed Labor Force in Areas of Displacement = Net Displacement Effects, or
4. Utilization of Resident Unemployed Labor Force - Net Displacement Effects = Net National Employment Effect

At the national level the output of the NRIES consists of two projections of national income and employment. One is based on the assumption that the project takes place; the other constitutes a reference line projection based on the assumption that the project does not take place. The difference between them, each year, is a measure of net primary benefits (provided by the sponsoring agency) plus the net national secondary benefits associated with the net utilization of otherwise unemployed labor resources.

Work is continuing on the development of this system. However, it will be several years before the models can become completely operational. We first need to develop a system of regional accounts largely composed of multi-regional input-output tables including corresponding interregional trade flows. When the complete system does become operational, it is expected its capability of measuring the benefits derived from the utilization of otherwise unemployed labor to be included as an objective of planning and accounting for those benefits in an integrated accounting system with respect to the regional and national accounts will facilitate the inclusion of regional development as an objective of water and related land resources planning.

Estimating Secondary Regional Economic Impacts
(A BEA Operational Model)

Inasmuch as the NRIES will not be operational for some time, we have been working on more partial procedures which can be used in the meantime and which will also have continuing value after the NRIES is completed. I am now going to describe procedures developed in BEA for estimating regional impact multipliers. These multipliers will partially fulfill the requirements of the Principles and Standards for determining the income and employment changes generated by a water and related land resources project or program.

These multipliers can be used analytically in that they are reliable approximations of the total intraregional effects of some initial change in a region, and also they permit the analyst to identify differences between alternative courses of action.

Our procedure generates a unique I-O type multiplier for each industry by which an initial regional change is transformed into a total regional change. The procedure accomplishes this in an inexpensive manner with a system of programs and regional data files.

Total regional economic impact includes the primary impact and the secondary impacts as well. While the primary impact results from the production in industries directly affected by the program or project, secondary impacts result from the chain of regional expenditures set off by the initial change in production in primary-impact industries. That is, other regional industries will experience an increase in production simply because they supply inputs directly to the primary-impact industry. In addition, each industry that realizes an increase in production will increase its payments for the services of the region's labor force, thereby increasing household income and, in turn, comsumption expenditures and regional production.

Overview of Estimating Procedures

Total impacts are estimated by means of industry-specific regional output or earnings multipliers. In general, multipliers represent a ratio of total change (in output, earnings, or employment) to some initial change, which we call the primary impact. The multipliers developed are "industry specific" in that a unique value is estimated for each regional industry for which a primary impact is predicted.

The procedures that are employed are generally applicable. That is to say, they are not limited to analyses of special problems. Multipliers may be estimated for any industry in any county, group of counties, or State. The industry for which a multiplier is estimated may be any four-digit (SIC) manufacturing industry, while three-digit detail is possible among the other industry divisions. These multipliers are of the Input-Output (I-O) type and are analogous to the industry-output multipliers generated by an I-O model for a region. The total output change of an initial final demand change is the product of the multiplier and the final demand change. These I-O type multipliers, however, are estimated without the actual construction of a full regional I-O model.

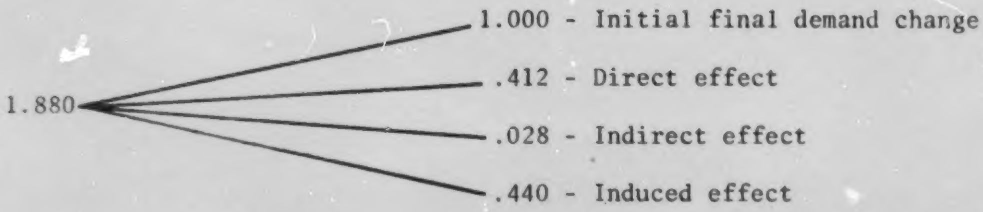
The time and manpower required to construct a regional I-O model often exceed the resources available to a particular research project. Further, such an effort need not be undertaken in any case, if the resulting model is only used to estimate impact multipliers. The multipliers developed by this procedure are sensitive to differences between industries, as are the I-O multipliers, and they can be readily re-estimated for any region composed of counties.

Multiplier estimation is accomplished by dividing the multiplier into three components - the direct effect, the indirect effect, and the induced effect - and by using a variety of secondary data in estimating each effect. See Figure 2.

The direct-effect component is derived from an I-O model direct-coefficient table - it is the sum of the column for which a primary impact is predicted. Each element of this column represents the purchase required from other industries per dollar of output of the primary-impact industry. The direct effect represents the first round of additional regional expenditures resulting from the primary impact.

Metals Industry Multiplier

Total multiplier



Grain Products Industry Multipler

Total multipler

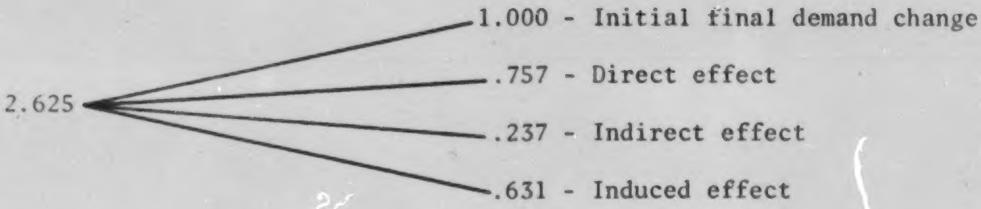


Figure 2 Decomposition of Selected I-O Multipliers for Nebraska

Source: Theodore W. Roesler, F. Charles Lamphear, and M. David Beveridge, The Economic Impact of Irrigated Agriculture on the Economy of Nebraska, (Lincoln: University of Nebraska, Bureau of Business Research, 1968).

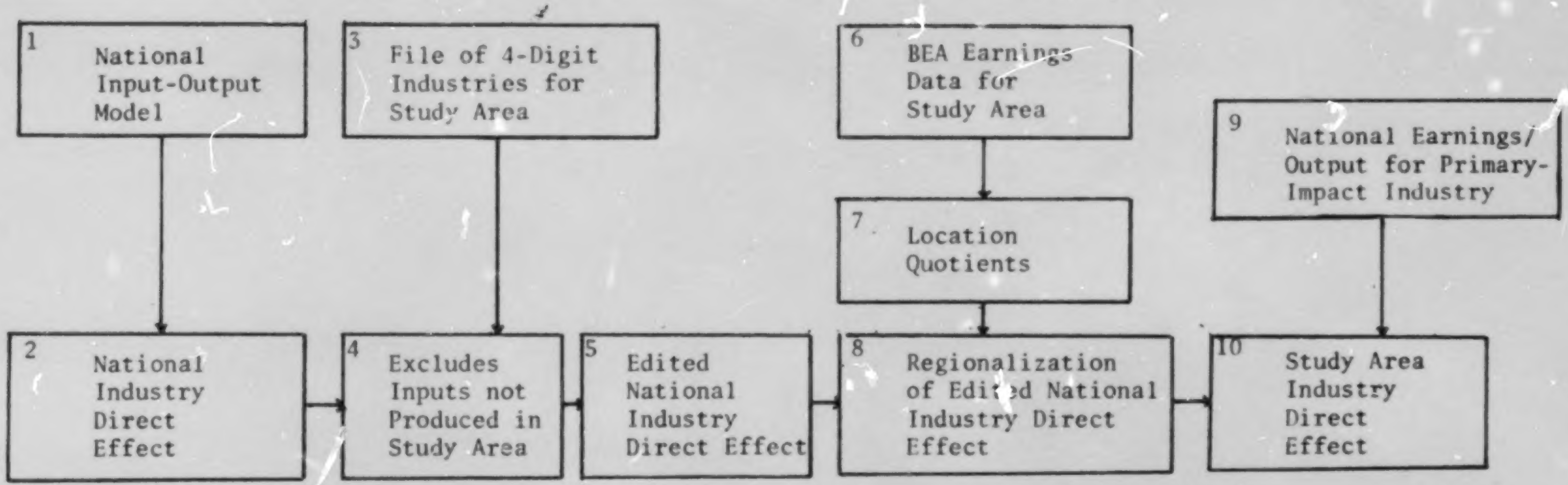

1 National Input-Output Model
3 File of 4-Digit Industries for Study Area
6 BEA Earnings Data for Study Area
9 National Earnings/ Output for Primary-Impact Industry
7 Location Quotients
2 National Industry Direct Effect
4 Excludes Inputs not Produced in Study Area
5 Edited National Industry Direct Effect
8 Regionalization of Edited National Industry Direct Effect
10 Study Area Industry Direct Effect

Figure 3 Direct-Effect Estimation

The indirect and induced effects summarize additional rounds of regional expenditures resulting from the primary impact and can be defined in terms of the I-O model. The indirect effect represents additional rounds of interactions between industries that indirectly supply inputs to the primary-impact industry. The induced effect results from a change in regional household income, from the subsequent change in regional consumption expenditures, and from the regional production that goes to support that consumption.

The approach used involves estimating the direct-effect component of the multiplier by scaling down a column from the national I-O model and be regionalizing it. The indirect and induced-effect components are estimated by examining the functional relationship between the direct component of I-O multipliers and the corresponding indirect and induced components.

Direct-Effect Estimation

Estimating the direct-effect component of the output multiplier for a particular regional industry involves estimating the structure of inputs for that industry. The starting point is the 478-industry version of the national I-O model, which permits the selection - as a primary-impact - of almost any four-digit SIC manufacturing industry.

The procedure outlined (Figure 3) includes the following steps:

1. The national gross flows - or transactions - for the primary-impact industry are extracted from the national I-O model, indicating the dollar value of purchases from other four-digit industries.
2. Gross flows are converted to national direct coefficients by dividing each purchase by the primary-impact industry gross output. The resulting coefficients represent the purchases from each supporting industry per dollar of primary-impact industry gross output. The sum of these coefficients is the national direct effect.
3. County Business Patterns four-digit SIC county data are used to create a file of industries present in the aggregation of counties comprising the study area.

4. This file is then compared with the column of input-requirement coefficients derived from the national I-O model to check for the regional production of specific input requirements.
5. In cases where a particular input is required but not produced in the study area, that element of the column of input requirements from the national I-O model is deleted, thus producing a column of edited coefficients.
6. BEA earnings data, by county, are assembled into the county configuration of the study area.
7. A location quotient is calculated for each industry in the study area. For a given industry, it is the proportion of regional total earnings represented by the industry, divided by the national proportion.
8. The final step of regionalization of the column of input coefficients is the application of a location quotient (L.Q.) criterion to the elements of the column of edited national coefficients in order to determine whether, in each case, there is sufficient local production in a given supplying industry to permit the input to be purchased in the study area. If sufficient production is not present, the coefficient is adjusted to reflect the portion of the requirement likely to be purchased, (If the L.Q. is less than one, the coefficient is multiplied by the L.Q.)
9. The labor requirements of the primary-impact industry are calculated, in terms of earnings, based on the national ratio of earnings to gross output.
10. The direct-effect component of the multiplier for the study area is the sum of the regionalized edited national industry direct-effect coefficients and the national earnings/output ratio. The latter element brings the household into the direct effect.

A number of assumptions are made in the process of estimating the component: first, the primary-impact industry employs the same technology of production in the study areas as is embodied in the national I-O model and second, in applying the location-quotient criterion to scale down the national coefficients, the portion of particular regional industry's output sold to the primary-impact industry is the same as in the national

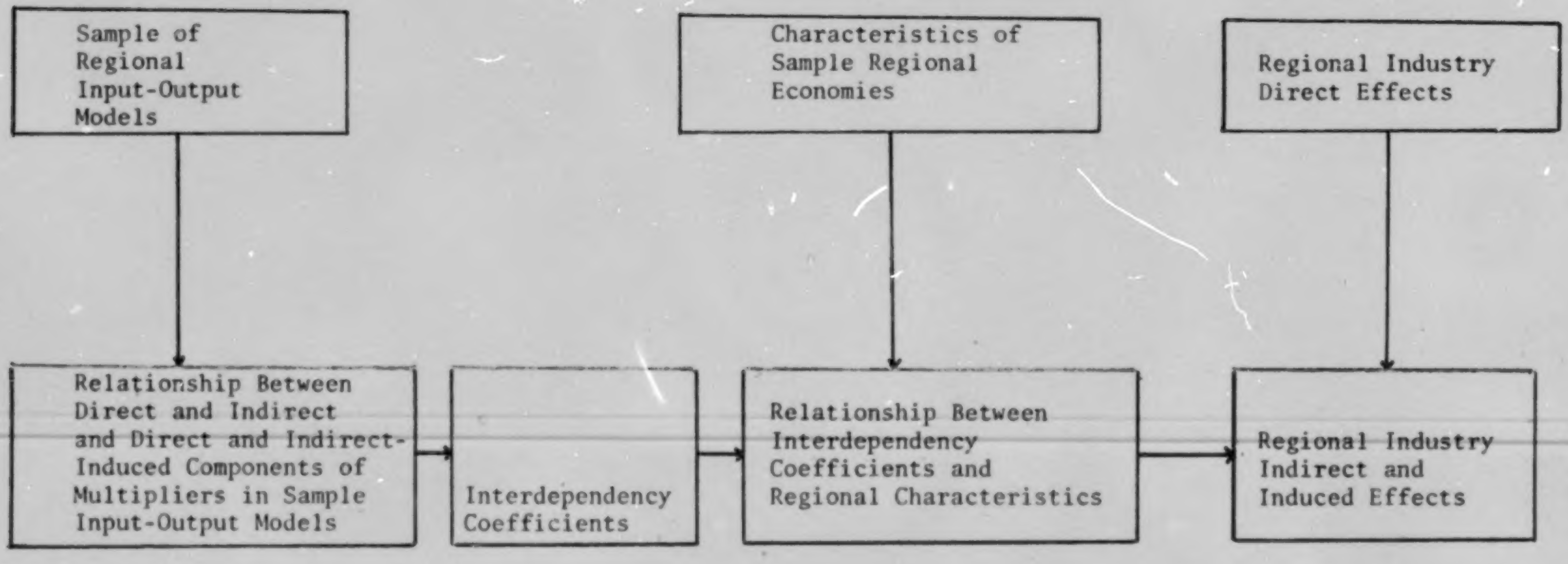

Sample of Regional Input-Output Models
Characteristics of Sample Regional Economies
Regional Industry Direct Effects
Relationship Between Direct and Indirect and Direct and Indirect-Induced Components of Multipliers in Sample Input-Output Models
Interdependency Coefficients
Relationship Between Interdependency Coefficients and Regional Characteristics
Regional Industry Indirect and Induced Effects

Figure 4 Indirect- and Induced-Effect Estimation

I-O model. Finally, it is assumed that the proportion of industry expenditures paid to households, primarily for labor services is the same as that for the Nation as a whole. We believe these assumptions are reasonable for most areas but we are now involved in empirical studies which will determine their applicability.

Indirect- and Induced-Effect Estimation

The direct component of the multiplier, discussed above, accounts for the output effect of direct requirements purchased by a primary-impact industry. The total effect includes indirect interactions between industries and induced effects resulting from personal consumption expenditures of local consumers whose incomes are affected by the direct and indirect effects.

The approach used for estimating the indirect and induced components of the mulitplier evolves from empirical and conceptual findings. In an I-O model, and under empirically common conditions, the indirect (or indirect plus induced) component of the output multiplier can be estimated by a linear homogeneous function of the direct component. In the I-O framework, the component is added to the multiplier by including households as a sector in the model; payments to households for labor services are represented by a row and sales to households by a column. In this scheme the household sector does not differ, conceptually, from any other industry. Estimates, therefore, are developed for the indirect component alone and for the indirect and induced components of the multiplier.

In the procedure by which the indirect and induced components of the output multiplier, for a specific regional industry, are estimated (Figure 4), a sample of regional I-O models, representing a wide cross section of regional economies in terms of size and industrial diversity, was first collected. An interdependency coefficient--representing a single-value description of the degree of interaction between industries in the economy--was estimated for each regional I-O model. The purpose of this step was to test the hypothesis that the indirect effect component of the multiplier could be estimated as a linear homogeneous function of the direct effect component. It was found that 85 to 95 percent of the variance in the indirect effect component could be explained by this simple function of the direct component.

The next step was to explain the value of the interdependency coefficient in terms of the characteristics of each regional economy. With this relationship established, it was then possible to predict the interdependency coefficient for the region for which there was no I-O model. The size of the economy, in terms of total earnings, was used as the explanatory variable in estimating the interdependency coefficient.

Projecting Total Impacts: Output, and Labor Earnings

Projected total output changes are estimated by applying the appropriate area and industry multipliers to the projected primary impacts. Projected labor earnings impacts are also estimated. Earnings ratios for each area are derived from the OBERS projections.*

The multiplier estimating system is operational. To use it, a request must be made to the Regional Economic Analysis Division, BEA. The system cannot be turned over to others to run because confidential data files are used in the estimating. The request for multipliers should specify: (1) the area to be included, and (2) the industries for which multipliers are required. Those requesting this service will probably want to consult with the BEA staff in the determination of the area and industries involved. The cost of the service will be about $1,000 for each area.

---

* Forthcoming publication, Bureau of Economic Analysis, 1972, OBERS Projections: Regional Ecnomic Activity in the U.S.: Series E Population, U.S. Water Resources Council (Washington).

MEASUREMENT OF SWB EFFECTS

Dirk P. Lijesen
Consultant, INTASA
Menlo Park, California

The role of this account is to display the effects resulting from the interactions between the inputs and outputs of a plan and the social and cultural setting in which these are received and acted upon. Social well-being effects are to "be displayed where appropriate to give further assistance to the decision maker."

A previous paper considered the nature of the information to be displayed in both the RD and SWB accounts, problems in implementing the Principles and Standards, and a process of focusing planning and evaluation on important linkages between water resource systems and the effects described. This paper focuses on discussing alternative means to approaches measuring SWB effects in line with the broad mandate presented in the Principles and Standards.

Summary of Principles and Standards

Table I presents the text of the Principles as it relates to SWB. Table II presents a summary of the Standards with respect to SWB. To gain familiarity with the intent of this account the reader should carefully review these tables. In broad terms the following points set the tone for the subsequent discussion.

- The term "where appropriate" in Table I is not defined for any of the effects described, even though a planner/evaluator is expected to include only effects considered appropriate.
- There are few if any formal methods mentioned in Table II that the planner can use in attempting to satisfy the Principles and Standards. There is no clear definition of the effects to be measured, let alone the methods to be used in measuring them. As a result measuring SWB effects can be considered more art than science.

Table I

TEXT OF THE PRINCIPLES

For each alternative plan, the beneficial and adverse effects on social well-being will be displayed where appropriate (Page 8).

B. Beneficial and Adverse Effects on Social Well-Being

The beneficial and adverse effects of a plan to be displayed where appropriate in the social well-being account include:

a. Real income distribution. The effects of a plan on the real income of classes or groups that are relevant to the evaluation of a plan will be displayed. All effects, both monetary and income in kind, will be included in this display.

b. Life, health, and safety. Plan effects on life, health, and safety other than those evaluated monetarily for the national economic development objective will be included here. Measurement techniques will vary but would largely be in terms of physical units.

c. Educational, cultural, and recreational. The effect of the plan on educational, cultural, and recreational opportunities.

d. Emergency preparedness. The effects of the plan on reserve capacities and flexibilities in water resource systems and protection against interruption of the flow of essential goods and service at times of national disaster or critical need will be displayed.

e. Other. Other effects on social well-being may be identified and displayed as relevant to alternative plans (Pages 9, 10).

Table II

SUMMARY OF STANDARDS WITH RESPECT TO THE SWB ACCOUNT (FROM PAGES 82-84)

Component	Type of Effect	Suggested Indicators	Suggested Methodology	Comments Made
Real Income	- Change in real income designated persons or groups generated as a result of the plan. Adverse effect include increases taxes and reimbursement costs.	- Net amount of total and per capita income as dollar values.	- No specific methodology is mentioned.	- Current guideline defining the family poverty line may provide basis for measuring absolute and percentage changes.
Security of life, health and safety.	- Effects include: • Change in risk of flood, drought, or other disaster affecting the security of life, health and safety. • Change in the number of disease-carrying insects and related pathological factors. • Change in the concentration and exposure to water and air pollution. • Provision of a year-round consumer choice of foods that contribute to the improvement of national nutrition.	- No specific indicators are suggested.	- No specific methodology in mentioned.	- Where available based on historical data, projections in terms of the number of lives saved or the number of persons affected may be provided. In most cases a descriptive-qualitative interpretation and evaluation will applicable.
Educational, cultural and recreational	- Effects include: • Changes in opprotunities for community services such as utilities, transportation, schools and hospitals. • Changes in cultural and recreational opportunities such as historic and scientific sites, lakes and reservoirs.	- No indicators are suggested.	- No specific methodology is mentioned.	- Changes in opportunities for community services may be described in appropriate quantitative terms. Changes in cultural and recreational opportunities will be described in terms of the numerical change in relevant facilities, otherwise accounting for size, use, potential and quality.

Table 11 (From pages 92-94)

Component	Type of Effect	Suggested Indicator	Suggested Methodology	Comments Made
Emergency preparedness	- Effects include: • Changes in extent, maintenance and protection of major components of the national water transportation system. • Flexibility of water supply reserves. • Availability of critical power supplies (ample stable, quickly responsive). • Availability of reserve food production potential. • Conservation of scarce fuels. • Capability for dispersal of population and industry. • Contribution towards international treaty requirements.	- No specific indicators are suggested.	- No specific methodology is mentioned.	- These are to be measured in appropriate quantitative units where readily practicable, but will be largely characterized in descriptive-qualitative terms.
Other	- None desctibed.	- Not Applicable	- Not Applicable	- Other effects on social well-being may be identified and displayed as relevant to alternative plans. Note: This component functions as a "catch all."

- Confronted with such a situation one of the first requirements is to indicate the type of methods that the planner can draw upon in starting the SWB measurement process and the delineate guidelines that will provide focus to this process. To this end, in the following section the outline of an approach is presented and remaining sections address illustrative examples of SWB assessments.

Approach

A. Introduction

The measurement of SWB effects is a process of gathering and structuring information on how proposed water resource systems can affect people, both in the region under study and elsewhere in the nation. This discussion is concerned with the problems of measuring impacts within the study region. Extension of concepts to include people affected outside the region can be accomplished once an approach is implemented within the region.

As indicated in the Principles and Standards much of the argument to be made in the assessment of SWB effects is qualitative. The strength of the argument is going to rest on how clearly individual effects are identified and linked to the water resource system. The following steps outline a procedure for gathering information, identifying the affected part of the population and assessing the importance of the effects.

B. A Stepwise Procedure

Step 1: Baseline Description of the Region

The first step in identifying SWB effects is to develop a description of the study area which will highlight social issues relevant to the study area. The baseline description should capture the range of objectives and concerns in the social domain that potentially can be related to water resource evaluation. The following guidelines are suggested:

- For the information developed it is important to provide a comparison with other regions, and perhaps the U.S. as a whole. This will indicate the relative condition of the study area or its parts.
- The categories of information to be examined are essentially contained in Table II. In addition it is suggested that information be provided on social concerns related to (1) population displacement and/or dispersal; (2) employment; (3) housing; and (4) aesthetics. Although for each of these categories indicators are included

in the other three accounts, the rationale for inclusion of concerns related to these categories in the SWB account is that they all carry aspects that go beyond the mere statement of changes. For example as a result of employment changes a community might experience a drastic change in public image which in a particular study area may be a significant social issue. A baseline description should contain such information.

Step 2: Direct Linkage with Water Resource Plans

Having identified the base characteristics of the region, the next step is to identify direct linkages with water resource plans. E.g., flooding can directly affect the housing stock through damages and preventing further development in an area. Another example is that a navigation project may directly influence the number and types of jobs in an area both in the short (construction) and long term (new industry).

The product of this step is a list of direct linkages between social issues identified in the baseline description and the water resource plans.

Step 3: Identification of Affected Population and Social Impact Study Area

The purpose of this step is to introduce two concepts - Affected Population and Social Impact Study Area - into the assessment process aimed at providing further focus. The rationale for inclusion is clear: without defined boundaries practical procedures are doomed to fail because no attempt is made to separate the important from the unimportant. Moreover, making these concepts operational is difficult and requires the planner's judgments. The following guidelines are suggested.

- Affected Population. On the basis of the identification of direct linkages, the population most directly affected can be identified. This may be in terms of one or a combination of the following:
  - Geographic area.
  - Age.
  - Race or ethnic group.
  - Income.

  The basis for defining the affected population should be the type of local problem involved and the nature of the linkages with the system. E.g., flooding affects a geographic area; as a result the population inside the floodplain could be chosen as target population and contrasted with the population outside the floodplain. However if the main linkage between flood control and social effects entails income redistribution a better definition is provided by stratifying the population according to income levels regardless of where they live in the study area.

- Social Impact Study Area. A social impact study area can be defined which represents (1) an area at whose boundaries the sensitivity between the water resource system and the social effect under consideration drastically "drops" and (2) an area which facilitates the handling of data on existing conditions and potential effects. For example, if income redistribution is the issue, census tracts with 20 percent or more of the families below the poverty level may be selected as the Social Impact Study area. Other data on education, employment and housing can then be used from those census tracts as needed.

Step 4: Estimate Direct Linkages

For each direct linkage identified, an estimate should be made of its magnitude for the selected target population, and the degree to which it alleviates local problems. E.g., the potential number of housing units that would be added with flood protection could be estimated and related to the housing needs described in the baseline information.

Step 5: Estimate Multiplier Effects

An assessment should be made to determine if the direct effects have multiplier effects important for overall community development. There are three characteristics of the effects of water resource plans to be considered here:

- Community Motivation. If the plan alleviates a severe local problem, residents may find greater incentive to participate in community improvement efforts. E.g., if flooding and associated home damage are eliminated local homeowners may be more willing to maintain or improve their homes.
- Community Resources. Improved water resource development may conserve community resources. Again using flooding as an example, the need for cleanup, road repair and other efforts might be eliminated,

allowing local funds to be used for more desirable purposes such as improving parks.

- Combined Effects. The direct linkages as a whole produce multiplier effects they could not achieve alone. E.g., a combination of improved housing and job opportunities may be needed in a community before there is a substantial change in its social characteristics.

C. Summary

The approach described here suggests steps that a planner/evaluator can take in assessing SWB effects:

- Develop a baseline description of the study region and compare it to other regions using the components of Table II.
- Identify direct effects of water resource plans on those components.
- Identify the people affected and define an appropriate social impact study area.
- For the social impact study area estimate the effects of the plans and relate to the initial description of the total region to show the relative effects.
- Determine multiplier effects affecting the overall well-being of the social impact study area.

SWB Measurement: Illustrative Examples

A. Introduction

The purpose of this section is to provide an overview of SWB measurement by presenting a number of illustrative examples. SWB measurement procedures can be broadly classified into two groups. In the first group the emphasis is focused on analyzing effects within each particular component of the account. In the second group the focus of the procedure is on developing a composite picture of the effects on community well-being supported by analysis of individual components. The premise for such composite analysis is that the "total" social impact of a water resource plan is more than can be discovered by the analysis of individual components. In particular the emphasis in composite analysis is on the identification of effects whose interaction is such that the total impact surpasses a certain threshold of significance; a fact which is not obvious from individual component analysis.

In Section B assessment of public health effects and recreation opportunities exemplify individual component analysis. In Section C two composite analyses are discussed representing two recent efforts in SWB measurements. Each of the following sections allows for a set of observations regarding the SWB measurement process. These are set out in the conclusions following each example with the intent of passing on what has been learned from actually performing SWB assessment. In line herewith it is asserted that, for some time to come, the assessment of the SWB effects will have to be improved in a similar manner, i.e., more actual assessments have to be performed that provide the experience and "case study" data that precedes more rigid metholology development.

B. Individual Component Analysis

1. Alternative Approaches for Estimating Changes in Public Health

a. Introduction

The concern here is to assess the potential threat of disease and toxic effects in terms of the potential changes in incidence and the nature of the impact on the affected individual. Typically, evaluations of health impacts are presented in highly qualitative form, indicating only that in the judgment of the evaluator there is a greater or smaller chance of certain diseases or toxic effects occurring due to water programs. This was done in the five pilot studies in wastewater management, e.g., in the Southeast Michigan study, Appendix G (Ref. 1). An alternative to this approach assesses the relative importance of possible effects resulting from water resource programs and presents an overview of the health program dealing with both the uncertainty in any estimate of impacts and the severity of different types of impacts. This approach was applied in a recent study of the San Francisco Bay area for the Corps of Engineers (Ref. 2). The study showed, for example, that wastewater disposal at particular sites can result in increases in rabies and the nuisance of pasture mosquitoes. The chance of the mosquito nuisance is greater than for rabies, but the severity of rabies infection is greater than that of mosquito bites for the individual affected. Because the latter procedure is more explicit in dealing with the public health problem, it is recommended for application in areas with potentially major health effects.

b. Recommended Procedures

In this subsection the recommended procedure is described in terms of data requirements and the method used to encode physical judgment on the probability of a disease or nuisance occurring and its severity. The discussion is abstracted from an unpublished paper prepared by Dr. Robert C. Cooper, School of Public Health, University of California at Berkeley.

1. Information Needs. In assessing the public health hazard, it is important to consider (1) the agent, (2) the dose, (3) the dose response, and (4) the dose contact.

The agent is the cause of the disease and may be classified as either biological or chemical. The biological agents include bacterial, viral and parasitical organisms. They may be either directly transmitted to man via the water route or indirectly by water resource management practices resulting in the development of disease. The chemical agents can be subdivided into organic and inorganic components. Direct transmission of these via water is normally the rule; however, transmission of the chemical in its original or transformed state via the food chain must also be considered, e.g., the conversion of mercury to methyl mercury and the subsequent concentration of this component in fish. A comprehensive list of agents is given in Table III.

The dose is the concentration of agent delivered to the exposed population. It must be considered not only in terms of concentration but also in terms of duration of exposure. The dose of biological agents depends on the prevalence of disease already in an area plus whatever changes occur due to the treatment processes that are introduced. The dose of chemical agents depends on the degree of treatment and the existing concentration of those agents in the region's waters. With regard to chemical agents, solids management is an important concern and must be assessed as a potential source of pollution. Information on the expected concentrations of biological and chemical agents should be available from the treatment system designer.

The dose response is the rate of infection of the population at risk; it depends upon factors such as virulence or toxicity of agents involved, age distribution of population exposed, socioeconomic factors and in some cases racial mix. That dose of agent to which a susceptible population responds is an area in which the least amount of information is available and is the most

Table III

AGENT CATEGORIES

A. Infectious Enteric Diseases Assoicated with Water

  1. Bacterial

    a. Typhoid Fever
    b. Salmonelia (other than typhoid)
    c. Shigella
    d. Other*

  2. Viral

    a. Infectious hepatitis
    b. Enteric viruses

  3. Parasitical

    a. Amoebic Dysentery

B. Zoonotic Diseases

  1. Arthropod Borne

    a. Arthropod borne encephalitis
    b. Murine typhus

  2. Nonarthropod Borne

    a. Rabies
    b. Leptospirosis
    c. Tularemia
    d. Swimmers Itch

C. Noninfectious diseases

  1. Toxic Chemicals

    a. Inorganic Chemicals

      (1) Heavy metals
      (2) Nitrates
      (3) Hardness

    b. Organic Chemicals

      (1) Halogenated hydrocarbons
      (2) Carbon chloroform extractable (CC) and carbon extractable (CAE)
      (3) Other organics depending upon industry present

  2. Allergens

    a. Pollens
    b. Dusts

  3. Nuisances

    a. Rodents
    b. Biting Insects
    c. Ordors

---

* Other would include disease peculiar to a study area as may be determined by local and state health authorities. Such a category is implied in each agent category.

difficult to assess. Therefore, the information is best found by soliciting the judgment of practicing physicians and public health officials.

The dose contact is the exposure of an individual to an agent. The primary modes of contact are by:

- Ingestion of water through drinking and cooking.
- Recreational contact which may be direct as in swimming or indirect as in fishing and boating.
- Inhalation of airborne agent.
- Association with wildlife, including insects.

The dose contact by the susceptible population from possible contamination of surface and groundwater supplies should be estimated in terms of the number of people using these various supplies. This is principally determined in light of wastewater effluent disposal methods, although the impact of multipurpose impoundments (flood control, recreation and water supply) on the sanitary quality of drinking water should also be considered.

Water resource developments will often increase the population's potential contact with disease agents through swimming, boating, fishing, hiking, hunting, and similar past times. The projected number of man years or visitor days related to the water resource program should be ascertained. Disease vector impact should be estimated from estimates of domestic mammal population, information usually available from the State Department of Agriculture, and estimates of hematophagous arthropod populations, primarily mosquitoes. This latter estimate would require information concerning area (acres or square miles) of breeding sites both existing and projected, and control measures (water management and mosquito abatement) presently available and proposed. The local health department or mosquito abatement district should be the source of these estimates. Estimates are needed of vertebrate populations, particularly the avian fauna, small mammals and wild carnivores. Finally, there should be a description of the major geological features of the general geomorphology of the region, and descriptions of the types of natural vegetation and types of agriculture. The effect of water management upon these conditions must be projected in order to understand potential changes in the population of animals of public health importance, and should be done by an ecologist. The general data requirements are summarized in Table IV.

Table IV

GENERAL DATA REQUIREMENTS FOR HEALTH ASSESSMENT

A. Present incidence of disease (morbidity and mortality data that may be available).

B. Human population at risk, present and future
   1. Population size
   2. Age and race distribution
   3. Population in contact with health problem
      a. Recreational contact in all its forms reported in "man days"
      b. Drinking water supply and how it will be affected by management schemes
      c. Food sources affected by water management (irrigation)

C. Land Area Involved
   1. Size
   2. Geomorphic province
   3. Vegetation type
   4. Surface and ground water sources

D. Climatic Data
   1. Air and water temperatures (average and seasonal range)
   2. Rainfall and humidity

E. Wildlife census affected with particular reference to reservoir, vector and nuisance animals.

2. Assessment Procedure. The assessment requires systematic encoding of the professional judgment of practicing physicians using the information just described. The two factors mentioned earlier, the probability of a change in incidence and the severity of the disease or toxic effect, are to be assessed by the physicians. The procedure separates considerations of the two factors so that the evaluation of severity is made in terms of its effect on life expectancy, degree of disability, and degree of treatability, but not with regard to incidence. The judgment by experts can be encoded by selecting a point on a linear scale from 0 to 100, where the end points of the scale are represented by agreed-upon health categories. The judgments are thus relative in comparison to baseline problems.

The probability of a health problem occurring is necessarily a subjective judgment given the present state-of-the-art in public health problems related to water resource systems. Therefore, it is recommended (1) that a "public health problem" be defined for each disease category in terms of either any increase in incidence or a specific level of increase, and (2) that the experts judging the severity of the problem estimate the probability of such an increase. Estimation of probability can be presented on a linear scale of 0 to 1 where zero means no probability of increase in problem and 1 means 100 percent probability of occurrence. This can be described mathematically as:

$$S_i = \frac{\sum_{J=1}^{n} P_{iJ} S_J}{\sum_{J=1}^{n} S_J} \qquad (1)$$

Where S_i is the expected magnitude of public health change due to management procedure i; P_{iJ} is the subjective probability that procedure i will produce public health problem J $(0 \leq P_{iJ} \leq 1)$; S_J is the physician's opinion of the relative severity of a public health problem J $(0 \leq S_J \leq 100)$; and n is the number of public health problems being evaluated. A detailed description and application can be found in Reference 2.

c. Conclusions

From the public health methodology discussed several conclusions can be drawn on the measurement of SWB effects:

- The example demonstrates how the state-of-the-art can be advanced with new methods. The approach developed here gives the planner/evaluator much greater capability to deal with public health problems.
- The detail of the information categories and the expert knowledge required to assess the range of potential diseases shows the effort needed for an in-depth serious examination of an SWB component.
- The procedure for utilizing expert opinion provides a systematic and formal approach for overcoming a lack of data. Effective classical statistical studies of public health problems are impractical with present data sources. This approach permits more to be done than simply indicating there may be a health threat by being more precise in terms of (1) the chance of a problem arising and (2) its relative severity for the afflicted individual.

- The methodology is derived from the field of decision theory and applied to the field of public health. Throughout the SWB account it is important to recognize the need for multidisciplinary efforts in SWB measurement.

2. Recreation Opportunities

a. Introduction

This component portrays the social implications of changes in recreation opportunities caused by a water resource plan. Approaches for the analysis of three situations are discussed; (1) there are no specific planning objectives for recreation, but the evaluation must display the overall value of the plan; (2) specific objectives have been set, and the evaluation must capture system contributions to objectives; (3) the evaluation must assess the adequacy of a facility's design.

b. Approach for Analysis without Specified Objectives

When planning objectives for recreation have not been set, there must be an attempt to portray the "value" of a system's effect on changing the amount and type of recreation opportunities in a general manner. Traditionally, this has been done through some form of dollar measure, using either an estimation of "willingness-to-pay," or an assumed dollar value per visitor day multiplied by total visitor days created. These approaches were reviewed in References 3 to 7. Based on the assumption that these approaches, as currently applied, do not fully capture the value to society of providing recreation opportunities, it is recommended that the following approach be used. There are two critical elements to this approach: a regional profile of recreation and an estimation of the change in visitation due to the plan.

1. Regional Profile

To display the value of a change in recreational opportunities, it is necessary to provide an estimation of the change, and, in addition, a profile of the problem addressed. This profile can serve as a basis to judge the value of the changes. It consists of a comparison of the regional demand and supply for specified recreational activities, such as water-skiing, fishing, and swimming. First, demand and supply must be determined for the recreational activities, and expressed in common units for a specified time period, e.g., acres or number of people per peak day. Based on this information, the supply and demand can be composed to give an overview of deficiencies for specific activities in the region.

While data on demand is usually available on a yearly basis the recreation facilities are normally used at different levels during the year. Problems that arise can be seen from the following discussion.

If W_j is the percentage of total yearly visitations that occur on day j, a problem can be seen in the following example. People do not swim in January in winter climates; however, they might use a boat on a sunny January Sunday. In this situation, W_j is zero for swimming days in January, while W_j is not necessarily zero for boating days during the same period. Thus, total yearly demand should be distributed over all days in the year to assess issues such as peak day demand and average summer demand. It should also be noted that resource planning is frequently performed to accommodate the peak demand or some fraction of it, thus for purposes of resources planning the main emphasis in estimating the distribution of W_j is on the accuracy of the peak demand forecast, which means that inaccuracy in estimating "off-season" demand can be tolerated. However, accurate estimation of W_j for "off-season" periods is warranted in order to acquire insight into the time periods when existing supply is only partly used.

Distribution for W_j should be estimated for different activities to account for activity differences and to reflect expected recreation behavior in the study area. It would be possible to make these estimates on the basis of visitation statistics applicable to recreation sites in the area; however, if statistics are not available, an attempt can be made to synthesize demand estimates on the basis of visitation surveys presented in the literature (Ref. 8; Ref. 9, pp. 141-146; Ref. 10; Ref. 11; Ref. 12, Chapter 16; Ref. 13). Some typical time distributions that would be useful are average summer weekday, average summer Saturday, average summer Sunday, average summer peak day, and average over summer months. The steps to derive these statistics are: (1) distribute visitation over seasons, (2) distribute visitation months within each season and, (3) distribute visitation over days within each month taking into account the difference between weekdays, Saturdays and Sundays.

The number and type of facilities available for different types of recreation are an input to the evaluation from the design phase. This data should be in the form of number of participants that can be accommodated during a day. (In this example, demand and supply are taken to be in terms of participants. Thus, supply data must be converted from acres to participants The comparison could just as well be made in terms of acres with demand being converted from participants into acres of land or surface acres of water.) If the data is not available in this form, it must be converted. Often facility information is provided as a number of acres of land or surface acres of water. A factor for converting between acres and participants will be needed for each recreation activity. This factor is a composite design standard to express how surface acres are expected to be used; it can be formulated in terms of a number of elementary standards which means that it is possible to formulate assumptions regarding expected use more precisely. For example, some elementary standards that could be combined to determine the number of people who can participate in power boating during a day are:

- Activity-unit density (e.g., the average number of surface acres required per boat).
- Standard group size (e.g., the average number of people per boat).
- Turnover rate (e.g., the average number of boats that can use the "same acre" during the day, or, the average number of acres demanded that can be satisfied by one "physical" acre during the day).

If no generally accepted standards exist for the study area, data can be used from other sources. Some sources of standards are References 8, 9, 10, 11, 04, 15, 16. A cursory review of the various standards used by different agencies shows that a wide range of values exist. It should be recognized that without careful consideration of the standards to be used, serious overestimation or underestimation of the acres required to support a particular recreation activity can result.

Given the above information on the demand and supply for different activities, a comparison is made to determine regional deficiencies. From this determination analysis should identify specific objectives which plans can address.

2. Estimation of Visitation Changes

This analysis is used to determine visitation to individual sites and to estimate the change in visitation due to providing new facilities. If a new site is provided, or an old one expanded, the increase in participation at the site is estimated on the basis of both participants who formerly recreated in other sites and new participants who did not recreate before. Only the latter participants cause an increase in benefits. A complete description of the flows of visitors from each population center to every recreational site available for the particular activity is necessary in order to distinguish the redistribution of visitation from the genuinely new visitation. Thus, the visitation at individual sites and the change in total visitation for the region are considered together. The model recommended for determining the change in visitation when individual sites are added or expanded considers the redistriubtion of participants among the sites in calculating the new regional visitation. This model is described below, for the activity of power boating.

For allocating the recreation visitation from population centers to sites, the study area is divided into zones such that one point, usually the centroid, in a zone is taken as the source of all trips originating within that zone. The study area would be divided into zones reflecting the type of output desired, such as for geographic areas of similar socioeconomic characteristics. The recreation sites form discrete points of destination. For the allocation from points of origin to sites, a gravity flow model, described in References 17 and 18, is recommended. This model uses an index of attraction for a particular site from a population center (which is most commonly an indicator of site capacity, such as total water area devoted to boating or total acres of improved facilities such as boating ramps) weighted by distance or travel time raised to an exponent. Determining the coefficients in the model requires calibration with data on present visitation from the specific population centers to the individual sites. As this type of information is not usually available, the following form of the gravity flow model is recommended (for further detail see Reference 19).

Let P_i be the population at center i and V_{ij} the visitation in visitor days at site j from poulation of center i. The ratio V_{ij}/P_i reflects the relative attrattiveness of site j for the resident of center i. This ratio is assumed to be proportional to the supply s_j offered at site j, and inversely proportional to the distance r_{ij} between center i and site j. This is expressed by

$$V_{ij}/P_i = \gamma_i \cdot s_j/r_{ij} \qquad (2)$$

where γ_i is a normalization coefficient. For instance, a ten acre reservoir five miles away from center i attracts as many people as a twenty acre lake, located ten miles away.

The total power boat visitation from center i is thus

$$V_i = \sum_{j=1}^{n} V_{ij} = \gamma_i P_i \sum_{j=1}^{n} s_u/r_{ij} = \gamma_i \sigma_i P_i \tag{3}$$

Where n is the number of sites and σ_i is given by

$$\sigma_i \triangleq \sum_{j=1}^{10} s_j/r_{ij} \tag{4}$$

and represents the value or attractiveness of all available supply for the residents of center i, expressed in acres per mile. It can be expected that centers with low σ_i will proportionally engage in less power boating than better supplied centers, i.e., having a bigger σ_i. Let d be the attractiveness of all activities (possibly nonrecreational) which are different than power boating; d is also expressed in acres per mile and is assumed identical for all centers. The propensity to power boat which is given by $\gamma_i \sigma_i$ in equation (3) depends on the attractiveness of power boating relative to the total attractiveness of power boating and nonpower boating activities $(\sigma_i + d)$ Hence the equation

$$\gamma_i \sigma_i = \sigma_i/(\sigma + d) \tag{5}$$

or alternatively

$$\gamma_i(\sigma_i + d) = 1 \tag{6}$$

for all the centers. Thus all the normalization coefficients γ_i can be determined once d is known. The constant d is chosen to match a known average power boating participation rate β, i.e., to satisfy the equation

$$\sum_{i=1}^{m} V_i = \beta \sum_{i=1}^{m} P_i \tag{7}$$

where m is the nth number of population centers. The data required is the regional visitation rate for the particular activity without the plan.

Using the model, the visitation at each site with both the project-added capacities and the original sites is calculated. The visitation at all sites is summed to give the total regional visitation with the project. Regional visitation without the project is then subtracted to find the increase in regional visitation. This increase in regional visitation can be used in the economic account by attaching a dollar value and/or directly displayed in the recreation opportunities component of the social account.

With this model it is possible to project the visitation at particular sites, and to study the degree of overcrowdedness at the sites. Since the model gives the number of visitations originating from each population center to each site, it is also possible to display the average distance that a person in each center must travel for a particular activity. Coupled with a characterization of the socioeconomic groups in population centers, the accessibility of the sites to different groups can then be determined.

Results from the regional profile analysis and the change in visitation analysis are synthesized in order to display the value of recreation opportunities provided by the proposed plan.

c. Approach for Analysis with Planning Objectives

When planning objectives have been defined for recreation, the evaluation must demonstrate how the plan has contributed to the objectives. Planning objectives serve a purpose which is analogous to the regional profile in the previous analysis, i.e., they provide the basis for judging the value of changes. In this situation, there are two steps necessary for the evaluation (1) an operational definition of the objective, and (2) a modeling of the relationship between the objective and the proposed plan. An example of this approach is given in Reference 19, pp. 135-144, where the need for substantially more data than is generally available is made evident.

d. Adequacy of Proposed Facilities

The purpose here is to determine the adequacy of a facilities plan. Based on a specified design, an estimate should be made of future use, in terms of type and amount. Then a determination should be made of whether the amount and types of facilities are adequate, and match the projected demand. Examples of concerns here include the availability of usable or developed land acres and water surface acres, access roads, food services, boat ramps and picnic tables. This information is necessary to assess whether the potential for recreation opportunities is realizable. While traditionally such analysis has been in the realm of the architect/engineer, the planner/evaluator's input is critical to resolve such questions as:

- What recreational design standards are appropriate:
- How should recreational areas be combined to best meet objectives or to satisfy regional needs?

- How can recreation facilities best be integrated with other plan elements?

e. Conclusions

The recreation methodology example illustrates the following about measuring SWB effects:

- The concern for SWB issues in recreation has advanced relatively far, e.g., equity of opportunities for the poor has been developed into planning objectives for recreational programs at least at a conceptual level.
- In practical terms the general application of planning objectives is severely restricted by the lack of data on supply and demand. Effective recreational planning and evaluation must be at the level of detail of individual activities such as boating and picknicking.
- As a result the implementation of a lot of good ideas for improving water resource development is never achieved.

C. Composite Analysis

Two examples are presented here of analysis with a broad focus on community well-being:

- Socioeconomic impact of providing flood protection in the Model Cities Program area of North Richmond, Califormia (Ref. 20).
- Assessing the impact of riverfront development on the low income area of Omaha, Nebraska (Ref. 19).

When analyzing a community, it is necessary to collect sufficient data to delineate the study areas. For example, income in terms of the percentage of families below the poverty level may be an important input. In the Omaha study, a value of 20 percent or more of the families below the poverty level in a census tract was the condition for including a tract in the "impact study area." In the North Richmond study, the Model City definition of the study area was used. As indicated earlier, local issues provide the basis for definition of the study area.

1. Model City Program

a. Approach

In understanding the approach followed, it is important to bear in mind that most of the crucial aspects of socioeconomic development in an urban community are not readily measured nor are they easily projected. Some of the pertinent factors may have theoretically been identified, but in practice they are usually surrounded by uncertainty. In some cases, large amounts of data may have been collected; however, it is seldom gathered and arranged in a fashion that provides adequate measures to help answer questions and assist in an evaluation task. Any analysis is bound, therefore, to be primarily qualitative. The particular viewpoint taken was greatly influenced by the nature of existing plans for community development provided by Model Cities. In other words, it was assumed that, to a large extent, the right questions had already been asked and the set of priorities appropriately chosen.

The analysis of impacts was organized to estimate effects related to the Model City Program under the following headings:

- Direct effects of flooding.
- Multiplier effects of flooding.
- Total effects of flooding on community development potential.

1. Direct Effects of Flooding

Model Cities Program areas whose main components are directly affected by continued flooding include environment, housing, business and economic development, and recreation. These effects are seen as:

- impact of damages under existing conditions and
- discouragement of further development.

If flooding is not removed, property damage, time lost from jobs, schools and leisure, health threats from contaminated water due to sewage backup, and interruption of municipal and county services would not be avoided. On the other hand, flood protection can be seen as contributing directly to the enhancement of community development objectives. There is not much assurance of appropriate quantitative interpretation of impacts in a problem like this, so considerable effort was allotted to the development of qualitative descriptions which would convey as much information as possible.

2. Multiplier Effects of Flooding

There is a variety of ways in which secondary consequences or multiplier effects of the above direct effects of flooding develop in all program areas. The scope of these multiplier effects is therefore analyzed in an attempt to sketch the mode of operation of the propagation process. In this manner, significant linkages are demonstrated and the procedure of describing the total effect is simplified.

All Model Cities Program areas are considered in this part of the analysis. Those that are intimately related to each other are grouped so that the analysis can be facilitated. The multiplier effects of reduced motivation, strained local resources, and the direct damage and deterrence of further development are described in terms of their impact on other socioeconomic indicators. In some cases, such as housing, where potential developers of new housing would be dissuaded by continued flooding, there is a clear relationship between primary damages and secondary consequences if the adverse factor is not removed. This allows the establishment of the role of flooding as an impediment in a quantitative way. In other cases such as education, health and crime, there is a more general relationship between conditions in the program area and the potential for overall development of the community. For instance, low educational attainment is typically associated with low average socioeconomic levels.

3. Total Effects of Flooding on Community Development Potential

Finally, the overall picture of the extent to which community development effort is undermined by flooding is assessed in order to summarize the socioeconomic characteristics of the community of North Richmond with and without flood control. This total impact depends upon the effectiveness with which flooding is removed and the degree of utilization of the development potential in North Richmond.

b. Development of Baseline

A description of the socioeconomic condition of the Model Cities Program area was developed using the components of the Model City Program. These are shown in Table V. The main points to be made are as follows:

- The data are readily available. Sources are noted, and it can be seen how available resources were tapped.
- Comparisons of Model City Program area data are made with other communities in the San Francisco Bay Area, or the U.S. as a whole.
- The information is specific enough to draw inferences on effects, direct or indirect, due to flooding.

c. Direct Effects

Since the objectives of studies vary widely, this section will simply illustrate some of the direct effects as they relate to the indicators in Table V.

Table V

SOCIOECONOMIC INDICATORS FOR MODEL CITY PROGRAM STUDY

	PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON
1.	PYHSICAL ENVIRONMENT		
1.1	Percent of community area inundated	25.8% for the Standard Project Flood (Corps of Engineers 1971)	Flood-free urban areas in the U.S.
1.2	Percent of housing units lying within Standard Project Flood Area	64.3% (Corps of Engineers 1971)	Flood-free urban areas in the U.S.
1.3	Likelihood of contamination through sewage backup due to flooding	Frequency of sewage backup: at least once a year (County Flood Control District) Potential health hazard (County Health Department)	No sewage backup is expected to occur in urban areas. (State Housing Code)
1.4	Air pollution due to potential future industrial expansion in the surrounding area	At present highest in the Bay Area. Very likely to increase. (Bay Area Air Pollution Control District)	Bay Area
1.5	Total budget for landscaping per dwelling unit	$1.75 per dwelling unit for street trees from Model Cities 1970-71 budget; labor to be supplied by City with very minimal private expenditures	Average for plant materials and street trees for typical subdivision 1% of unit costs (estimated by Model Cities staff June 1971)

	PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON		
2.	HOUSING				
2.1	Average value of owner-occupied unit	$12,400 (1970 U.S. Census)	$28,700 Contra Costa County $20,700 Contra Costa County for Blacks (1970 U.S. Census)		
2.2	Average monthly rent of occupied units	$66 (includes public housing) (1970 U.S. Census)	$128 Contra Costa County $90 Contra Costa County for Blacks (1970 U.S. Census)		
2.3	Percentage of dwelling units owned	32.6% (1970 U.S. Census)	49.7% Southside 57.9% City of Richmond 69.0% Contra Costa County 50.5% Contra Costa County for Blacks (1970 U.S. Census)		
2.4	Average annual rate of increase in housing stock over past 10 years		Southside	City of Richmond	U.S.
		1462 (1960 U.S. Census)	1557 (1960 U.S. Census	23,130	
		1425 (1970 U.S. Census	2043 (1970 U.S. Census	26,931	
		-3.70 Annual Rate	+48.6	+380.1	
		-0.26 Percentage Rate	+3.12%	+1.64%	+2.3%
2.5	Dwelling units constructed per year from 1963-1971	2.3 (Model Cities)	14.5 (Model Cities)	170.2	
2.6	Percentage of substandard housing		City of Richmond		
	Deteriorating	31.4%	8.5%		
	Dilapidated	8.6%	1.7%		
	Deteriorating and dilapidated	40.0%	10.2%		
	Total housing stock	1462 (1960 U.S. Census)	23,140 (1960 U.S. Census)		

	PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON
2.7	Percentage of low-rent public housing	18% (1970 701 Study)	3.24%, 1970 City of Richmond (Model Cities)
2.8	Average population per household	3.3 (1970 U.S. Census)	3.22 Contra Costa County 3.55 Contra Costa County for Blacks (1970 U.S. Census)
2.9	Percentage of units with 6 or more persons in household	14.4% (1970 U.S. Census)	9.1% 1970 Contra Costa County (1970 U.S. Census)
2.10	Percentage of single person households	28% (1970 U.S. Census)	13.8% Contra Costa County (1970 U.S. Census)
3.	EDUCATION		
3.1	Median years of schooling for those older than 25 years of age	8.2 years (1960 U.S. Census)	11.1 City of Richmond (1960 U.S. Census)
3.2	Average reading level at Verde School	Kindergarten children at reading readiness level or above: 38% 3rd grade tests at 2.2 grade level (Summary of ESEA Title 1 Evaluation 1969-70: Richmond Unified School District, Richmond, California.	Nystrom - Southside 88% 3.2 (Special Tabulation by Contra Costa Junior College for Richmond Model Cities)
3.3	Number of students enrolled in day or evening classes at Contra Costa Junior College as percentage of total population	2.7% North Richmond Residents (Contra Costa Junior College Sepcial Tabulation)	3.0% for whole MNA 2.6% for City of Richmond (Contra Costs Junior College Special Tabulation)

	PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON
4.	HEALTH		
4.1	Live births per 1000 of population	23.3	16.3 Contra Costa County
	Deaths per 1000 of population	8.1 (1966 Contra Costa County Health Department) NOTE: Above figures reflect characteristics of population composition rather than health conditions.	6.5 Contra Costa County (1966 Contra Costa County Health Department)
4.2	Use of own car as percent of all who go to County medical and social service offices (low car ownership in area and transit poor)	27% (Model Cities Transportation Survey, May, 1971. Total number surveyed 1276. By nature of visits, all are in low income group.)	Outside MNA 52% (Model Cities Transportation survey, May, 1971. Total number surveyed 1276. By nature of visits, all are in low income group.)
4.3	Water contamination through sewage backup due to flooding	Exposure of residents, rescue workers and street maintenance personnel to sewage contaminated floodwaters constitutes a definite health hazard. Contaminated food products must be disposed of. (Contra Costa County Health Department)	Flood-free urban areas in the U.S.
5.	SOCIAL SERVICES		
5.1	Growth of average individual welfare payments since 1960 versus price index	AFDC payments per family of One Parent 1960 $148 1970 $174 (Model Cities)	Consumer Price Index: 24.2% Increase 1960-1970 (Statistical Abstract of United States

PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON
5.2 Welfare Cases by Category		Contra Costa County
Old Age (OAS)	194	6020
Totally Disabled ATD	288	5045
Blind (AB)	19	363
Aid to Families with Dependent Children (AFDC)	610	12,740
General Assistance (GA)	119 (Model Cities)	NA (Model Cities)
5.3 Licensed Family Day Care Homes	2.8 per 1000 households (Richmond Model Cities Comprehensive Childcare Project)	Richmond Planning Area 3.5 per 1000 households (Richmond Model Cities Comprehensive Childcare Project)
5.4 Use of own car as percent of all who go to County medical and social services offices. (Low car ownership in area and transit poor.)	27% (Model Cities Transportation Survey, May, 1971. Total number surveyed 1276. By nature of visits, all are in low income group.)	Outside MNA 52% (Model Cities Transportation Survey May, 1971. Total number surveyed 1276. By nature of visits, all are in low income group.)
6. BUSINESS & ECONOMIC DEVELOPMENT		
6.1 Median family income	$4,515 (1960 U.S. CENSUS)	$7,092; San Francisco-Oakland SMSA (1960 U.S. Census)
6.2 Population 16 years of age and over (non-institutional population	2,839 or 64.2% (1970 U.S. Census)	United States 139,687,000 or 69.1% (1970 U.S. Census)
Civilian labor force as percentage of population above 16 years of age.	42% (1970 U.S. Census)	58.7% (1970 U.S. Census)
Unemployed as percentage of the labor force	27% (1960 U.S. Census) 1970 figure expected to be higher (Model Cities)	5.5% (1960 U.S. Census)

PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON
6.3 Distribution of employment by occupation, as percentage of the total labor force		
		Contra Costa County
Professional, technical, Managerial	4.0	25.4
Clerical, sales	8.7	23.
Craftsmen, foremen	12.5	16.5
Operatives	19.0	16.7
Other Services	20.4	8.5
Non-farm laborers	35.6	4.7
Farmers and farm laborers	0.0	1.6
	(1960 U.S. Census)	(1960 U.S. Census)
7. MANPOWER AND JOB DEVELOPMENT		
7.1 Total number of MNA residents eligible for manpower training as percentage of total population	CEP Target Area 15.8% (1970 Model Cities)	NA
7.2 Per capita cost for enrollees	$1,804 (1970 Model Cities)	NA
7.3 Total enrollment as percentage of total number of applicants	33.2% (1970 Model Cities)	NA
7.4 Placement rate of program graduates	458 placements since CEP's inception (1970 Model Cities)	For MDTA only, national placement rate: 53.4% 1963-63 Statistical Abstract of the United States)

NOTE: Figures are for CEP Target Area. No separate figures are available for North Richmond, but other indicators would lead one to assume higher number of applications for North Richmond
(Model Cities)

	PROGRAM AREAS	NORTH RICHMOND	BASIS OF COMPARISON
8.	CRIME AND DELINQUENCY PREVENTION		
8.1	Total Juvenile probation referrals per 100 of population	19.2 January - June 1970 (Contra Costa County Probation Records)	7.6 January - June 1970 City of Richmond including County portion of North Richmond (Contra Costa County Probation Records)
8.2	Juvenile probation for drug violations per 1000 of population		
	Marijuana violations	1.6	0.8
	Heroine and other narcotics	0.0	0.0
	Dangerous drugs	1.1	0.57
	Other drug law violations	0.0	0.0
	Total January-June 1970	2.8 (Contra Costa County Probation Records)	1.37 (Contra Costa County Probation Records)
9.	RECREATION & CULTURE		
9.1	Community land use for recreation per 1000 population	1.74 acres (Model Cities)	City of Richmond 4.30 acres (Model Cities)
9.2	Operational budget for recreation per capita	1970: $9.60 (Model Cities)	1970: $12.20 (Model Cities)

NOTE: Community recreational and cultural facilities are almost non-existent in North Richmond, depicting very low expenditures per capita and a low level of recreational and/or cultural activities. 9.2 reflects mainly current construction for City portion of North Richmond

- Environment. Indicators 1.1, 1.2 and 1.3, which are direct results of flooding, would automatically be changed to match those of standard urban areas that have the opportunity to achieve future development.
- Housing. The direct effects of flooding on housing are twofold: property damage and discouragement of further development. The degree to which poor housing conditions can be attributed to the flooding can be assessed by comparing North Richmond to a community with similar socioeconomic characterisitcs which is not subject to flooding. An example of this comparison is the Southside section of the MNA, which was developed at approximately the same time as North Richmond and has been occupied predominantly by Blacks of similar socioeconomic background. Indicator 2.5 shows the difference in the percentage of dwelling units owned, and 2.7 the difference in the rate of new housing development.

These two examples demonstrate the type of inferences that can be drawn. Further argument showed the development of new housing to be particularly sensitive to flooding because most of the developable land lay in the flood plain.

d. Multiplier Effects and Total Impact

A major concern considered under multiplier effects is the effect of flooding on community motivation and the strain on community resources. In particular the assessment of motivation provided a key to linking the effects of flooding to the overall condition of the community. Information on population changes is available from census data which show a 39.4 percent increase in the 15-24 year old group between 1960 and 1970, while the group most economically active, the 35-44 year olds, has shown a dramatic decline of 24.6 percent in the same period. Data on patterns of personal income indicators related to educational attainment strengthen the assertion that those families that attain higher socioeconomic status tend to leave the area. This finding, combined with information on employment and income gains made through the Model Cities Program, continued degradation of housing from flood damage and the increased availability of improved housing elsewhere in Richmond, presents a strong case that the productive element of North Richmond's population would in the future continue to leave the community.

With flood control there is a chance to reverse the situation. There would be no guarantee of success, but it would be possible to build on the temporary success of the Model Cities effort in areas such as education and employment and have a major upgrading of the community.

Without flood protection the most likely result for the community is that the intervention of Model Cities in North Richmond will have only marginal effects. Physical improvements will possibly deteriorate under continued flooding so that the appearance of the community will remain largely unchanged or worsen. Those individuals and their families benefiting from employment programs to the extent that they can move to a new neighborhood may well be expected to do so. New businesses and new housing will most likely not be profitable, so the economic life of North Richmond will remain depressed. Increasing demands will be made for social services. Associated with the low-income character of the community will be continuation of low performance in a variety of social programs significant for community development. The worst aspect of this situation will be the continued lack of sense of dignity and self-determination among community residents. The community will risk remaining isolated socially and economically.

e. Conclusions

The North Richmond study leads to the following conclusions:

- Achieving a community-wide change requires many component changes. Housing improvements alone would not suffice. The full range of Model Cities activities including housing is necessary to achieve a major upgrading of the community.
- The evaluation of SWB effects of flood control was supported by methodologies not related to water resources but to the social issues. Education, health, employment and other studies developed by local agencies were an important part of the evaluation. Also, the identification of needs and statement of priorities developed by the Model Cities Program was assumed to be the best available and was used to organize the evaluation of the flood control project.
- The major link between the flood control project and the success of the Model Cities Program is through the non-quantitative factor of community motivation. The key concern is keeping

better educated and employed people in the community, and that can only be done when there is incentive in terms of potential living and working conditions.

- This example illustrates that WB effects can be major determinants for decision making. On the basis of a refined benefit-cost analysis and the social analysis described here, a decision was made by the Corps of Engineers to proceed with the project.

2. Riverfront Development

a. Review of the Study

The study of Omaha was concerned with assessing the effects of reversing present trends of urban sprawl and concentrating further development of the area along the Missouri River. Continued urban sprawl will be referred to as Alternative A, riverfront development as Alternative B. Social implications are analyzed on the basis of examining each alternative's socio-economic impact on the city's low income areas, referred to collectively as the Impact Study Area. This area consists of census tracts with 20 percent or more families receiving incomes below the poverty level as shown in Figure 1. The analysis is primarily based on examining current trends in population, housing and unemployment.

The major conclusion is that under Alternative A downtown Omaha, and the Impact Study Area in Particular, will probably continue its present trend of deterioration. Under Alternative B there is the potential, but no guarantee, for a reversal of that trend. For Alternative A the deterioration would be a continuation of present trends in population, housing and employment as follows.

Population. As shown in Figure 1, with one exception, the census tracts east of 30th Street in Omaha have lost population between 1960 and 1970. In the impact study area, some tracts lost on the order of 50 percent of their residents, and in the area as a whole there was a 37 percent decrease. Table VI shows that a significant portion of the decrease occurred for people in the 25-44 year age bracket. The trends displayed in Table VII provide a clear picture of the overall deterioration of the area.

Housing. Housing construction has shifted in line with the population with most taking place in a semi-circle from the southwest to the

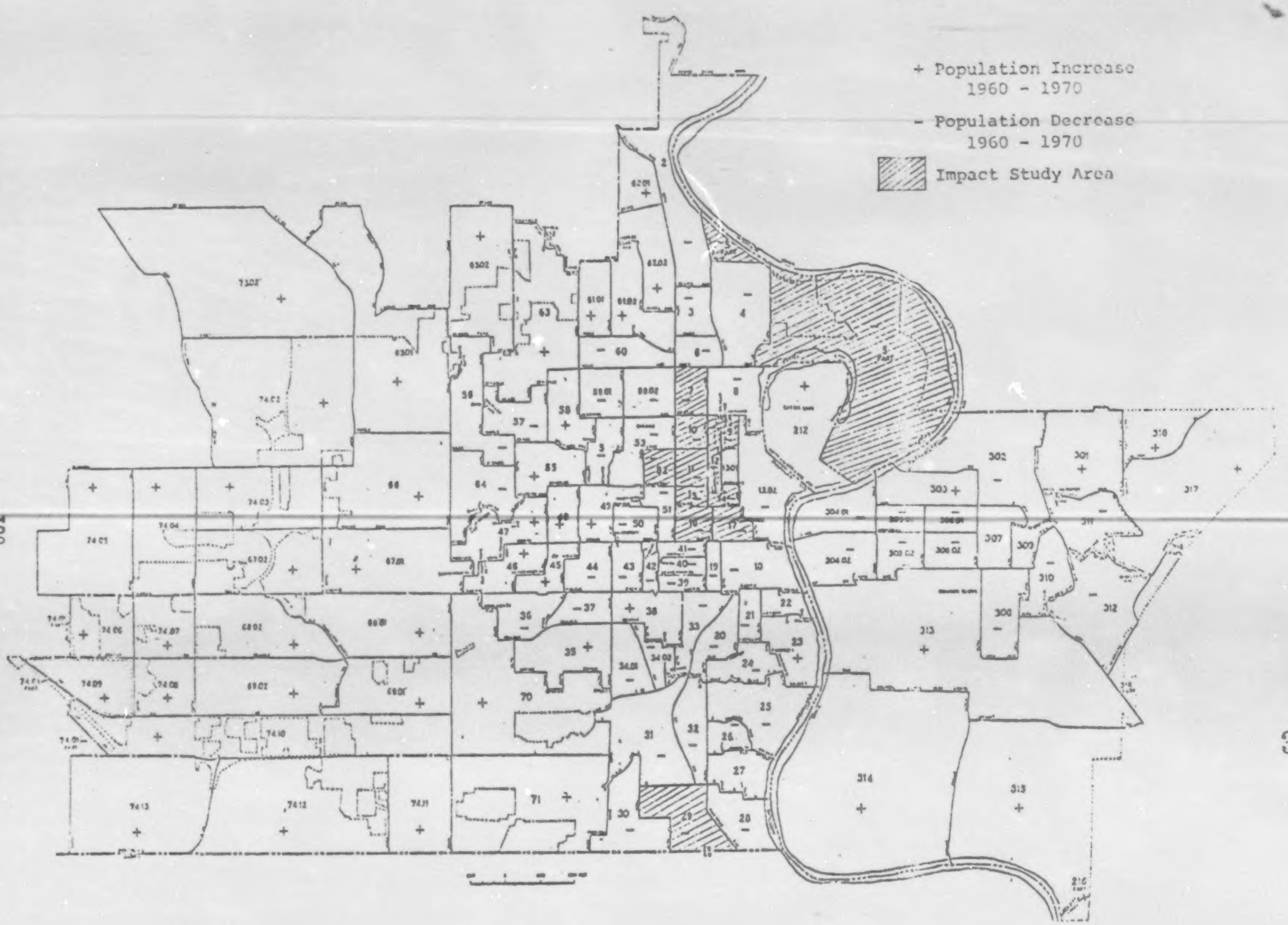


Figure 1 IMPACT STUDY AREA

Table VI

COMPARISON OF AGE DISTRUBUTION OF IMPACT STUDY AREA VS SMSA (Ref. 23)

IMPACT STUDY AREA

	≤24	25-44	45+
1970	51.5	18.4	30.0
1960	48.5	23.5	28.1
1950	40.5	29.7	29.8

SMSA

	≤24	25-44	45+
1970	49.0	24.4	26.6
1960	45.8	26.5	27.8
1950	39.9	29.7	30.4

Table VII

TRENDS IN THE IMPACT STUDY AREA (ISA), (Ref. 23)

	Population Total	Population As % of SMSA	Population As % of Omaha	Median Income		Unemployment	
				ISA	SMSA	ISA	SMSA
1970	29,359	5.4	8.5	3,441	8,288	7.5	3.0
1960	46,303	10.1	15.4	3,364	5,325	6.5	3.0
1950	47,737	13.0	19.0	2,152	2,922	4.7	2.6

	% Households Without a Car		Median House Price-Single Owner		Median Rent		Median Years of Schooling	
	ISA	SMSA	ISA	SMSA	ISA	SMSA	ISA	SMSA
1970	46.3	15.2	7,200	14,900	61	94	10.2	12.3
1960	43.2	18.9	6,800	11,600	53	67	9.7	12.0
1950	N.A.	N.A.	5,000	7,100	36	42	9.8	11.0

northwest part of the city. As most new units are being built for families with incomes of $12,500 or more (Ref. 21), this construction is aimed primarily at middle and upper income households. In the impact study area, there has been a reduction of housing units from 5,000 in 1960 to 3,400 in 1970. As dilapidated and deteriorated dwellings are demolished, there have not been low priced replacements. For example, in 1972 the area east of 30th street contained 11,000 households competing for only 1,700 units within their income ability. Table VIII shows that within the impact study area on the order of half the families in the income group below $5,000 pay 35 percent or more of their income for gross rent.

Employment. The major concern with the unemployment problem in the impact study area is that the westward expansion has attracted employment away from downtown, making it more difficult for area residents to commute to work, particularly when they do not have access to a car and must rely on public transportation. Evidence of the employment shift away from the downtown area is given by data in Reference 22 on the availability of office space, and by census data on total employment (Ref. 23). The proportion of suburban office space has grown from 6 percent in 1960 to 25 percent in 1973, and the average annual growth rates for office space have been about 3.0 percent for the city and 48.1 percent for the suburbs. Census data on employed population location show that in 1960 some 70 percent of the employed population of the SMSA worked in the city. By 1970 that proportion had dropped to 66 percent, despite the annexation of suburban areas. Also, substantial industrial development has taken place in the northwest portion of Omaha, and between Interstate 80 and L Street (Ref. 24). Because of the trend to locate employment away from downtown Omaha, the availability of either private or public transportation is an important consideration for residents of the impact study area. Table VII shows that in 1970 46.5 percent of the area's households were without cars compared to 15.2 percent for the SMSA. For those without cars, Metropolitan Area Transit bus service connects the impact study area with employment centers. However, commuting times to western employment locations from north Omaha areas are high. For example, to get from census tract 12 at Bedford and 30th Streets to either the center at 19th and L Streets or the Western Electric plant beyond 120th Street takes an hour and 20 minutes and includes one bus change (Ref. 25). Assuming 10 minutes getting to and from the bus stop, the daily round trip commuting time for some residents is three hours. As major changes in public transit that would significantly reduce these travel times are not likely at the present time, it is important that jobs be located near downtown if there is going to be a major reduction in unemployment for the impact study area.

Minorities. The proportion of Negroes in the impact study area is as high as 97 percent in some census tracts, and the area contains all the tracts in the SMSA with 80 percent or more Negro. Hence the deteriorating conditions of the impact study area have a disproportionate impact on the Negro Population (See Table IX).

Alternative B represents an opportunity to reverse these trends on the basis of the following observations:

- Population. - With growth centering around the downtown and the Riverfront, there would be an incentive to redevelop deteriorating neighborhoods and reverse the current population decline.
- Housing. New housing of 8,600 units projected for the RDP alone would be primarily for middle and upper income people. However relief for low income people would come from 270 units for the elderly and whatever percentage of the remaining 8,330 units that would be made available for low income occupancy.
- Employment. A total of 30,000 new jobs would be located within easy commuting of the impact study area with a range of job skill levels that would help reduce unemployment.

Since a large and increasing proportion of the residents of the area are Negro, these problems and opportunities have a major impact on the minority community.

b. Conclusions

The Omaha study demonstrates the following main points with regard to SWB effects:

- The social impact area is an excellent organizing concept for focusing on essential ideas and carrying out the analysis.

Table VIII

PERCENTAGE OF RENTERS WITHIN ISA PAYING 35% OR MORE OF INCOME FOR GROSS RENT

Census Tract	Less than $5000	Income $5000-9999
5	37.7	5.6
7	46.5	-
9	55.2	-
10	40.0	-
11	48.5	-
12	35.3	-
14	41.4	-
15	60.3	-
16	57.4	9.0
17	37.6	1.7
29	46.4	2.7
52	45.3	1.9
SMSA	56.0	4.2

Table IX

RACIAL MIX OF THE ISA

% Negro

	ISA	SMSA
1970	56.2	6.8
1960	42.5	5.7
1950	29.7	4.7

The poverty guideline used to define the study area and the use of census tracts as the basic area component facilitated the handling of a broad range of census data.

- Comparative analysis of the social impact area and local, regional or national data can identify important social trends. These may be more informative than absolute magnitudes of poverty or employment at any given time. Population declines are usually dramatic indicators of deteriorating neighborhoods.
- Although SWB measurement is typically confronted with an enormous range of social issues, and a great deal of uncertainty concerning possible future status of the region, it is possible to draw conclusions regarding the effects of major alternative water resource plans. By focusing on a social impact area and utilizing trend data the conclusions can be within reasonable limits of uncertainty.

REFERENCES

1. Alternatives for Managing Wastewater for Southeastern Michigan, prepared by the Detroit District, U.S. Army Corps of Engineers, July, 1971.

2. Cooper, R.C., et al., The Public Health Implications of Proposed Wastewater Disposal at Eight Selected Sites in the San Francisco Bay - Delta Area, The Sequoia Group, Berkely, California, January 1973.

3. James, L. Douglas and Robert R. Lee, Economics of Water Resources Planning, McGraw-Hill, New York, 1971.

4. Recreation Planning for Flood Control Reservoirs: A Case Study in the Papillion Creek Basin, Final Report prepared for U.S. Army Corps of Engineers, Omaha District, Omaha, Nebraska, by INTASA, Inc., Menlo Park, California, July 1973.

5. Kalter, Robert J., The Economics of Water-Based Outdoor Recreation: A Survey and Critique of Recent Developments, prepared for U.S. Army Engineer Institute for Water Resources, IWR Report 71-8, March 1971.

6. Methodology to Evaluate Socio-Economic Benefits of Urban Water Resources, Report prepared for Office of Water Resources Research, U.S. Department of Interior, by Louis Berger, Inc., East Orange, New Jersey, June 1971.

7. Socio-Economic Study of Multiple-Use Water Supply Reservoirs, Report prepared for the Office of Water Resources Research by Ralph Stone and Company, Inc., Los Angeles, California, January 1971.

8. North Atlantic Regional Water Resources Study Coordinating Committee, North Atlantic Regional Water Resources Study, Appendix M, Outdoor Recreation, May 1972.

9. Ralph Stone and Company, Inc., Socioeconomic Study of Multiple Use Water Supply Reservoirs, Report prepared for Office of Water Resources Research, Los Angeles, California, January 1971.

10. Nebraska Games and Parks Commission, Outdoor Recreation for Nebraska, A Comprehensive Plan, Volume 1, Lincoln, Nebraska, 1968.

11. Santa Clara County Flood Control and Water District, Feasibility Report for Calero Reservoir Enlargement Project, San Jose, California, December 1967.

12. James, L.D., and R.R. Lee, Economics of Water Resource Planning, McGraw Hill, 1971.

13. State of California, The Resources Agency, Department of Parks and Recreation, Outdoor Recreation Outlook to 1980, San Francisco Bay Area Metropolitan Complex, December 1966.

14. Bureau of Outdoor Recreation, Outdoor Recreation Space Standards, Department of the Interior, Washington, D.S., March 1970.

15. U.S. Army Corps of Engineers, Omaha District, Papillion Creek and Tributaries, Nebraska, Design Memorandum No. MPC-21, Recreation Resources Appendix Site 20, Omaha, March 1973.

16. U.S. Army Corps of Engineers, Omaha District, Review Report for Papillion Creek and Tributaries, Nebraska, Appendix V, Omaha, Nebraska, February 1967.

17. Homberger, W.S., Traffic Estimation Computer Programs for Educational Purposes - 4th Edition, Course Notes, Institute of Transportation and Traffic Engineering, University of California, Berkeley, September 1972.

18. Federal Highway Administration, U.S. Department of Transportation, Urban Transportation Planning, General Information, March 1972.

19. INTASA, A Comparative Analysis of Alternative Land Use Patterns for the Omaha Area, Final Report prepared for U.S. Army Corps of Engineers, Omaha District, Omaha, Nebraska, July 1973.

20. INTASA, Socioeconomic Impact of Flooding on Community Development in North Richmond, Final Report prepared for City of Richmond, Richmond, California, June 1971.

21. Campbell, E., and J.V. Hrupek, "Profile of Housing, Omaha, Nebraska," Ad Hoc Committee on Housing, 1972. See also R.H. Todd and D.W. Hinton, "The Omaha Housing Market: An Appraisal of the Occupancy Potential for Subsidized Rental Units, 1971-1973," Center for Applied Urban Research, University of Nebraska at Omaha, September 1972.

22. "Riverfront Market Framework Analysis," Discussion Draft, Gladstone Associates, Omaha, May 22, 1973.

23. U.S. Census data for 1950, 1960 and 1970.

24. Omaha Metropolitan Area Transportation Study, Supervising Consultant: Barton-Aschman Associates, Inc., Chicago, Illinois, May 1970.

25. Based on Omaha Metropolitan Area Transit (MAT) bus schedules.

APPLICATION OF SYSTEMS ANALYSIS TO THE PLANNING PROCESS

John W. Labadie

Department of Civil Engineering, Colorado State University

In recent years there has been an explosion in Systems Analysis techniques potentially applicable to a wide variety of planning, design, and management problems in water resources. This has been accompanied by similarly significant advances in high speed digital computer hardware and software. Few of these computer-based techniques, however, have actually been applied, either by governmental agencies or private firms, to real problems in water resources. In particular, the increasing complexity of water planning has drawn attention to the need for planners to take a serious look at what Systems Analysis can do to help in carrying out the difficult tasks before them.

One thing that is quite clear from the Water Resources Council's Principles and Standards is that they mean more work for water planners. Properly applied, Systems Analysis may help alleviate the increasingly heavy burden. Consider the following points:

1. The quantity and diversity of data available to be analyzed is increasing rapidly.
2. Engel (1) points out that Robert Heinlein's (of science-fiction fame) word "TANSTAAFL," or "there aint no such thing as a free lunc," is a relevant slogan for planners and systems analysts. Interactions between components of a planning problem are growing more complex, particularly with regard to environmental and social impacts of planning decisions.
3. Planning objectives are increasingly complex and noncommensurate.
4. The planning environment is changing rapidly, requiring continual updating and reevaluation of plans.
5. There is a greater interdisciplinary emphasis in planning.

Though the purpose here is to perhaps provide some encouragement toward greater application of Systems Analysis to water resources planning, there are some warnings and guidelines that need to be brought out. Many of those concerned about lack of application of Systems Analysis to water planning are also apprehensive about the dangers associated with its misuse. It is clear that the techniques of Systems Analysis can be valuable tools for aiding the planner, but like any tool they can be harmful if not used for their intended purposes.

What is Systems Analysis?

Modern Systems Analysis was born during World War II when Britain and the United States faced serious problems concerning proper allocation of scarce war materials to the various military operations. The successful application of techniques developed for this purpose prompted industry, business, and government to begin to apply these and subsequently developed techniques.

Systems Analysis (SA) can be described in concise terms as a *scientific approach to decision making*. It is a general term suitable to being considered as applicable to a wide range of planning, design, operational, and management problems. Other terms have been used synonymously with SA, but actually have a more narrow definition. *Operations Research* (OR) can be considered as Systems Analysis applied mainly to problems involving coordination of operations or activities in an organizational setting. OR has been a *technique oriented* discipline and most of the powerful computational mathematical programming algorithms have been developed by OR specialists. The emphasis is on building models that can be optimized in some way using these techniques. *Management Science* (MS) is oriented towards the same kinds of problems dealt with in OR, but with less emphasis on mathematical model building towards ultimate optimization. MS specialists may be more willing to deal with management problems not amenable to use of a formalized mathematical model.

Most texts dealing with SA give the following list, or some variation of it, as describing the steps in the systems approach to decision making:

1. Perception of problem and commitment to solution
2. Definition of problem
3. Formulation of objectives
4. Measures of effectiveness
5. Generation of alternatives
6. Evaluation of alternatives
7. Selection of recommended plan
8. Review, updating and feedback

Glancing over this list, many water planners may say that they have been doing this for years, though probably not in the same kind of formal order. To be more specific, then, the emphasis in SA is on at least some degree of *quantitative definition of component interaction and systematic generation and evaluation of alternatives*. The components might be economic sectors, river basins, reservoirs, etc. The idea is to properly describe complex component interaction in order to determine the possible consequences of various plans.

A commitment to attempt quantitative definition of component interaction naturally leads to consideration of use of tools such as mathematical simulation models, Delphi and cross-impact analysis, and gaming. The complexity involved in real-world modeling in turn leads to use of computers, due to their (1) speed, (2) accuracy, and (3) ability to process large quantities of data.

If objectives in the study are commensurate and quantifiable, optimization techniques may also be applied as an aid to systematic generation and evaluation of alternatives. If objectives are quantifiable, but noncommensurate, systematic methods for analyzing trade-offs between objectives may be applied, such as the Surrogate-Worth Trade-Off (SWT) Method proposed by Haimes and Hall (4). Figure 1 outlines the above steps.

The important point to be made here is that a willingness to apply SA does not necessarily mean a large-scale commitment to massive, complex modeling. Planners must be selective as to how much modeling they can carry out within constraints of time, budget, and manpower. They must also attempt to determine if significant aspects of the problem are indeed quantifiable to any degree and if use of mathematical models is

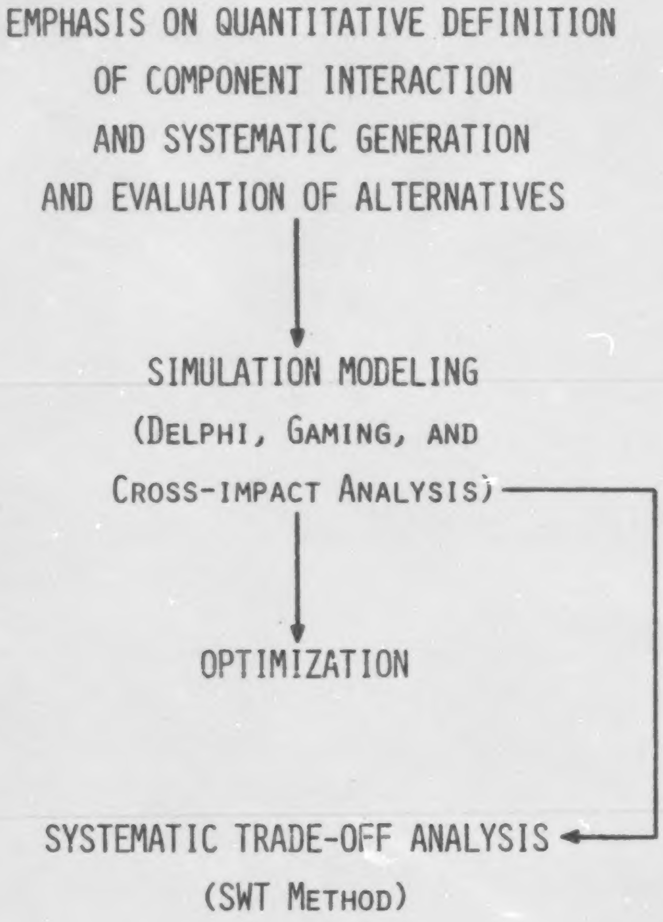

EMPHASIS ON QUANTITATIVE DEFINITION OF COMPONENT INTERACTION AND SYSTEMATIC GENERATION AND EVALUATION OF ALTERNATIVES
SIMULATION MODELING (DELPHI, GAMING, AND CROSS-IMPACT ANALYSIS)
OPTIMIZATION
SYSTEMATIC TRADE-OFF ANALYSIS (SWT METHOD)

FIGURE 1

TECHNIQUES OF SYSTEMS ANALYSIS

justified. It is important to realize that the judgment of planners must continue to play an important role in high level planning decisions.

Environment for Its Proper Application

Quick and Dirty OR

Gene Woolsey has coined the term *quick and dirty* OR to imply that systems analysts must avoid elegance and sophistication in modeling for its own sake. The proper attitude must be one of fitting the technique to the planning problem at hand, not *vice versa*. In other words, the tool must be matched to the job.

Simplification vs. Component Optimization

There are two important dangers involved in applying SA to a large-scale, complex planning problem: (1) over simplification and (2) component optimization. The former results when systems analysts attempt to develop a mathematical model for a problem so complicated that gross simplifications are necessary. The work of the Club of Rome and Forrester's *World Dynamics* would be examples of this. Component optimization is perhaps even more dangerous, where the interrelated parts of a large-scale planning study are analyzed independently, resulting in a decidedly nonoptimal solution for the whole. A proper balance must be achieved between these two approaches. Some simplification is always necessary. The danger lies in carrying the results of the simplified model too far and coming to unwarranted conclusions that have no basis. The reader is referred to Zoutendijk (9) for more complete discussion of the above points.

Honest Communication by Systems Analysts

Systems analysts involved in a planning effort have an obligation to...

1. Avoid SA jargon that will confuse planners not familiar with it and therefore hinder communication.
2. Clearly specify all limitations of analysis and reasoning that go into any modeling effort.
3. Clearly delineate all simplifying assumptions and approximations underlying the modeling.
4. Be acutely aware of the reality of *GIGO* or *garbage in--garbage out*. A model is only as good as the data available for its verification,

calibration, and operation. This is not to say that a model must not be developed unless all relevant data of proper quality are available. The modeling effort can many times help pinpoint data needs.

Proper Control by Planners

Planners have the greatest responsibility for maintaining the proper environment for effective application of SA. They are responsible for...

1. Controlling and guiding all SA specialists involved in the study. It is important to find the right people that are committed to solving the problem at hand, not advancing the state-of-the-art of SA in some theoretical vein.
2. Understanding and monitoring *all* modeling effort. It is dangerous to *leave it to the experts.* It is not necessary for planners to be expert mathematicians and programmers to get involved in the modeling. This was clearly borne out in the recently completed North Atlantic Regional (NAR) study, to be subsequently discussed.
3. Maintaining a high interdisciplinary profile in the study team.
4. Establishing a mechanism for continuous updating of any modeling. A computerized model should be so clearly documented that those not involved in its development can operate, modify, or update it as necessary.

John McCleod (6) has modified a statement found on all cigarette packages to emphasize the need for proper control of simulation modeling. *Warning--the simulationist general has determined that simulation* (Systems Analysis) - *misused - may be dangerous to the health of society.*

Case Studies

Two case studies will be discussed in order to illustrate the valuable effects that SA can have on the planning process. The purpose is not to get involved in the details of these studies, but rather to emphasize the advantages directly associated with application of SA in each case.

The North Atlantic Regional (NAR) Planning Study

The six-year NAR Planning Study (7) was initiated in 1966 under the supervision of the Water Resources Council. It was a broad framework planning study with the following objectives:

1. Estimate (on a broad scale) demand and supply for the entire North Atlantic Region
2. Identify priorities for investment
3. Identify priorities for further planning

This study, among other things, has proved that multiagency multi-objective planning can be effective if properly carried out. In this case, the executive agency was the U.S. Army Corps of Engineers, with Harry E. Schwarz serving as Executive Secretary. The management organization of the study is depicted in Figure 2.

The planning process is outlined in Figure 3. The study was initiated with development of three broad programs with NED, EQ, and RD emphasis, respectively. Appropriate agencies then proceeded to accumulate data and develop projections under these broad programs. This was followed by development of a computerized model to predict future demand for fresh, waste, and brackish water for M&I, rural, agricultural, cooling, power, and other uses, for all 50 subareas in the NAR region. It is particularly interesting that the model was developed jointly by agency personnel and SA consultants. Agency personnel were heavily involved in the model formulation. One result of the model was to pinpoint data needs not currently supplied by the individual agencies, from which resulted a limited (due to constraints on time) feedback process in order to acquire the necessary data. The demand model then served as input to a supply model which specified the best sources of supply and optimal levels of devices for meeting the demand. A linear programming problem was formulated for this purpose which sought to satisfy the estimated demand while minimizing average annual production costs, subject to EQ and RD constraints, as well as nonefficiency constraints and physical and resource limitations. The results of the supply model for each program aided in developing the final mixed objective recommended plan, based on the judgment of the planners.

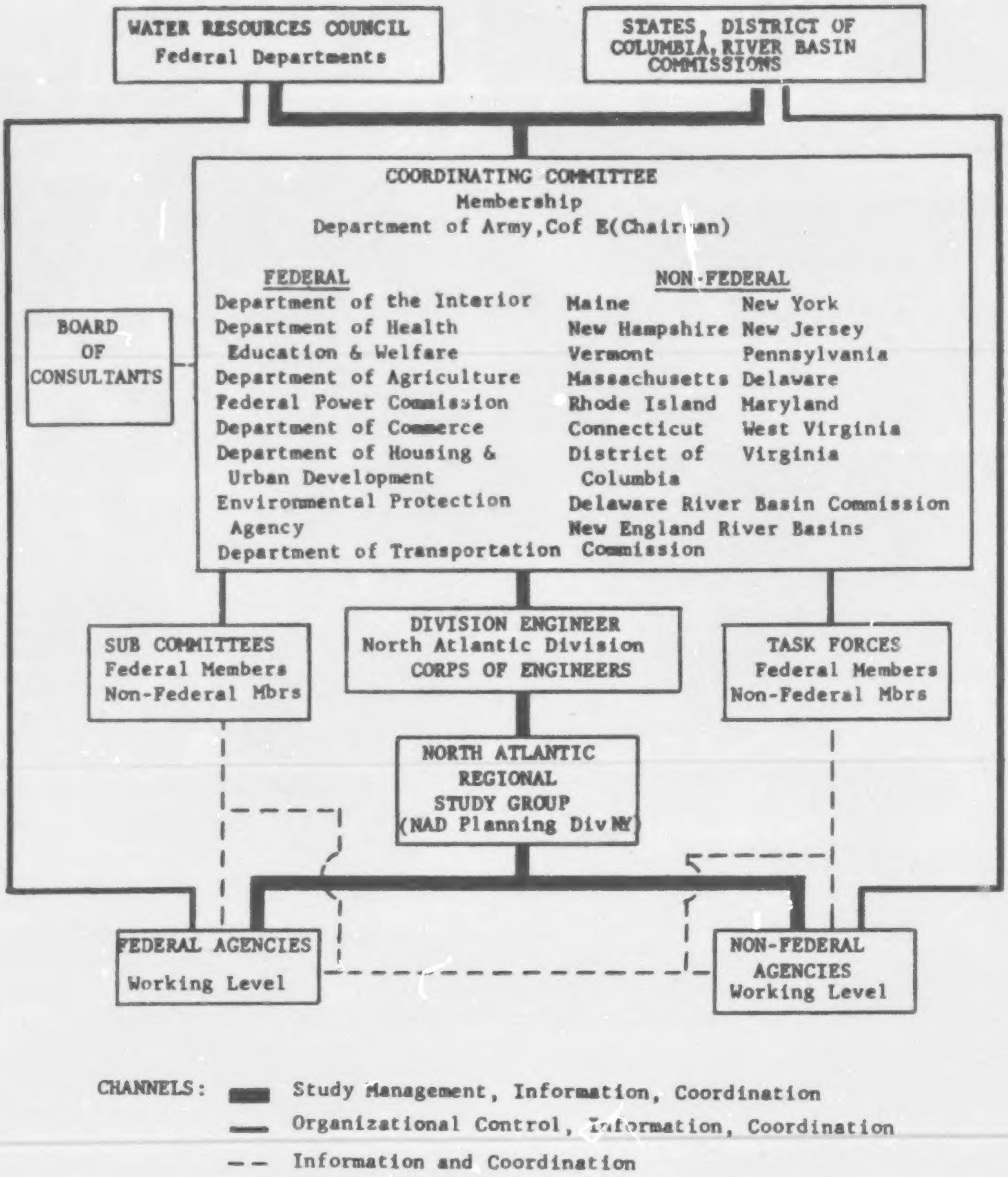


FIGURE 2

MANAGERIAL RELATIONSHIPS FOR

THE NAR STUDY, 1966-1972 [7]

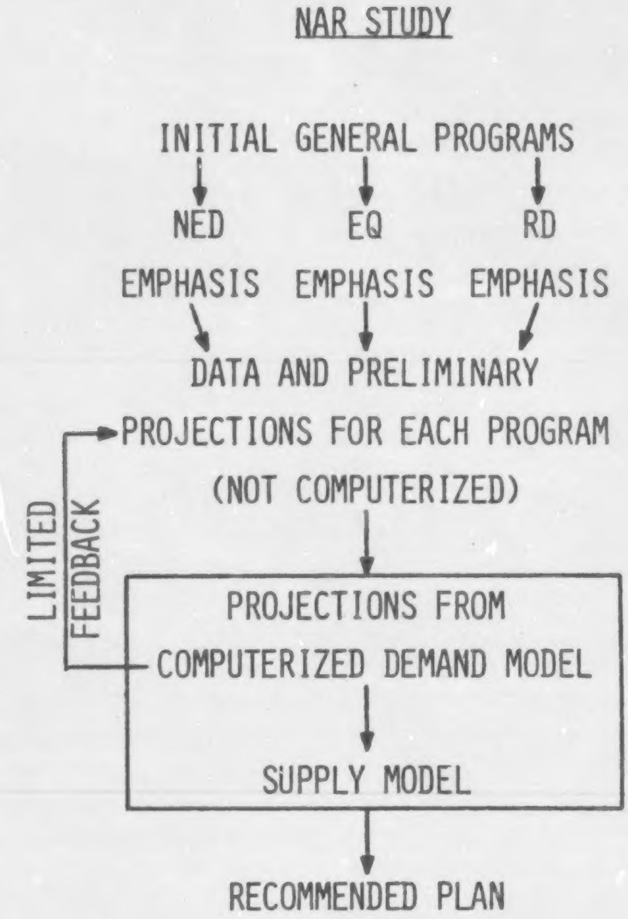


FIGURE 3

ABBREVIATED FLOW CHART OF NAR STUDY

Several important conclusions on the influence of SA on the planning process of the NAR study have been discussed in (5,8).

1. The models encouraged agency coordination and a team effort in cooperation with consulting systems analysts. The models tended to be a rallying point. Agency personnel were much involved in initial model formulation and therefore were interested in seeing it through.
2. As previously mentioned, the models helped pinpoint data needs.
3. The models encouraged careful documentation of all underlying assumptions and approximations used in the study, perhaps more so than if handcrafted methods had been used.
4. The carefully documented models provided a stronger arguing point in presenting the recommended plan to decision makers, than if handcrafted methods had been used.
5. The speed and flexibility of analysis through the modeling enabled more alternatives and projections to be considered than otherwise would have been.
6. "Perhaps, surprisingly, an important impact on the planning process of using models had been that the scope for exercise of the experience and judgment accumulated by planners has been increased rather than decreased. (5)"
7. Continuous updating of plans was encouraged due to the flexibility of the models. Inputs to the models could be easily changed, as opposed to noncomputerized methods which, when completed, are difficult to repeat with new inputs.

The San Francisco Master Plan for Wastewater Management (SFMPWM)

The following discussion of the SFMPWM will serve to highlight the following advantages of applying SA:

1. SA can aid in finding *cost-effective* solutions.
2. Tools of SA are available for effectively dealing with many large-scale problems without resorting to (1) a high degree of over-simplification, or (2) component optimization only.

The SFMPWM has been designed to deal with three serious problems related to San Francisco's combined sewer system (2):

1. Effluent from existing treatment plants does not meet current and proposed quality standards.
2. The interceptor sewer system is inadequate, resulting in considerable localized street flooding.
3. On the average, 80 overflow events of combined sewage to receiving waters occur per year. San Francisco Bay waters may be unsafe for water contact sports for up to nine months/year.

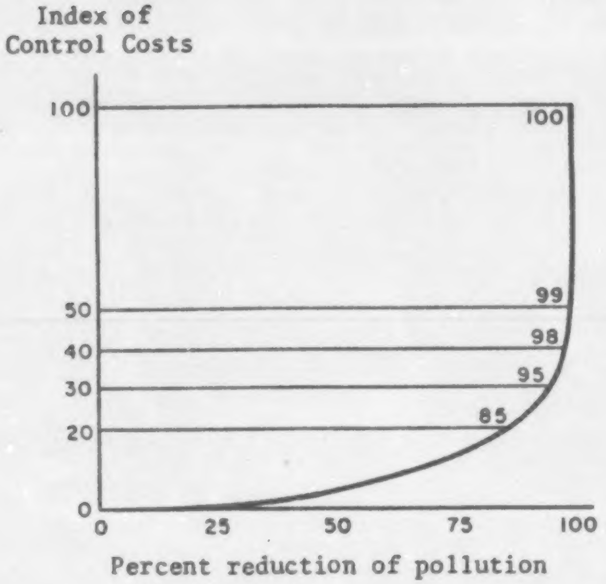
The goals set by the 1972 Amendments to the Federal Water Pollution Control Act are broad, and make it difficult to establish objectives for the SFMPWM. The amendments specify zero discharge of pollutants by 1985. It is questionable, however, if the nation can absorb the high cost of achieving zero discharge (See Figure 4). The developers of the SFMPWM have therefore opted to assume various tolerable levels of discharge and attempt to find the most cost-effective plans for achieving those levels. It is here that SA can be of great benefit. Final plan selection of course rests with the political process. The SFMPWM is in fact currently in this review process. It is estimated that the plan will cost between $300 and $800 million.

Several alternatives have been considered for dealing with the overflow problem in particular.

1. Separation of storm and dry weather flows
2. Massive treatment of combined flows
3. Treatment combined with detention storage

Sewer separation is extremely costly and inconvenient for a large urban center, and does not really solve the problem. Storm flows alone can contain high pollution loadings. Massive treatment of all wet weather flows is currently technologically infeasible. Secondary split flow treatment, in conjunction with upstream detention storage, that can hold peak flows long enough to allow treatment, was selected as the most viable alternative.

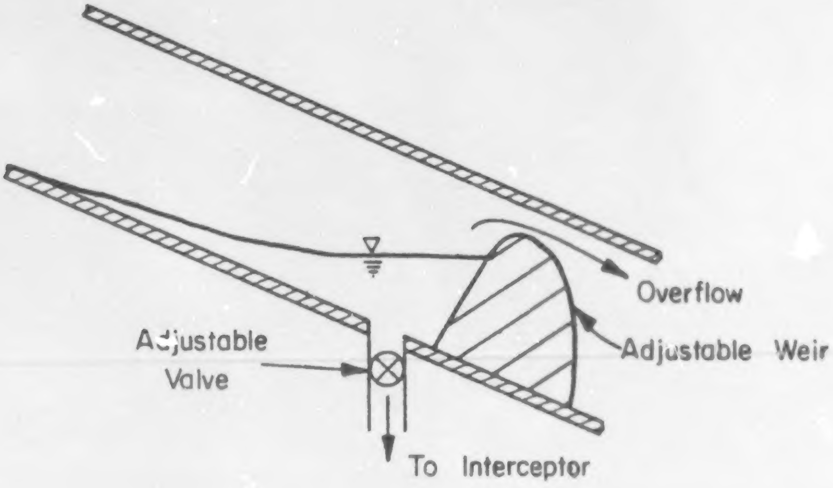
Sewage can either be temporarily stored ambiently (within the combined sewer by use of adjustable weirs) or through small concrete lined auxiliary reservoirs (Figure 5). San Francisco has chosen the latter, due to the steep gradients of the City.



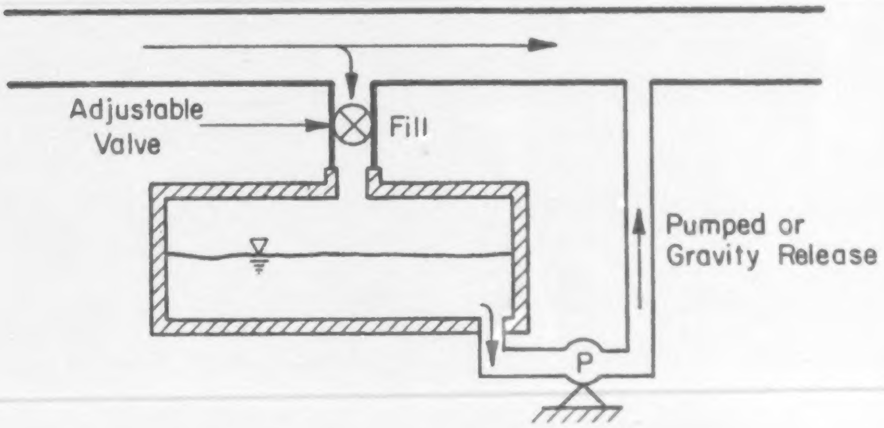
(Source: U. S. Environmental Protection Agency (1972). The Economics of Clean Water, Vol. I. U. S. Government Printing Office, Washington, D. C., p. 151.)

FIGURE 4

TOTAL POLLUTION CONTROL COSTS AS A FUNCTION OF EFFLUENT CONTROL LEVELS



(a) Ambient Storage (In – line)



(b) Auxiliary Storage (Off -line)

FIGURE 5

AMBIENT AND AUXILIARY DETENTION STORAGE

Figure 6 shows one of the alternatives for placement of detention reservoirs. The question immediately arises as to how to properly control inflows to and outflows from the reservoirs in order to make maximum use of treatment facilities and minimize overflows. Computerized automatic control appears to offer the most cost-effective solution. Mathematical models simulating flows in the sewer system during a storm event are developed, along with algorithms for optimally controlling all gates, valves, pumps, etc. in such a way that overflow is minimized (Figure 7).

Intensive effort is currently being carried out at CSU on this large-scale control problem (3). The large urban basin is decomposed into several *subbasins* tributary to interceptor sewers. Figure 6 shows this schematically, using the Richmond-Sunset area of San Francisco as an example. A hierarchical control structure can then be applied, where optimal control strategies are developed for the subbasins individually. The independent subbasin control strategies are then integrated together by computerized master control. The result is that instead of having to solve one large-scale, complex control problem, several smaller problems associated with each subbasin are solved a number of times. This means that a hierarchy of minicomputers can be used instead of one large computer.

The developers of the SFMPWM are well aware of the potential advantages of SA for achieving cost-effectiveness and dealing with the complexity of the control problem (2). Many problems remain to be solved, however, before these strategies can be implemented on-line in real time.

Conclusions

An attempt has been made here to define Systems Analysis and pinpoint its relevance to modern water planning. The discussion has been characterized by both encouragement and warnings concerning application of Systems Analysis. The two case studies discussed, the North Atlantic Regional Planning Study and the San Francisco Master Plan for Wastewater Management, served to highlight the advantages and feasibility of applying Systems Analysis to water planning.

In considering the possibility of applying Systems Analysis, water planners must decide whether to hire consultants, have their own personnel

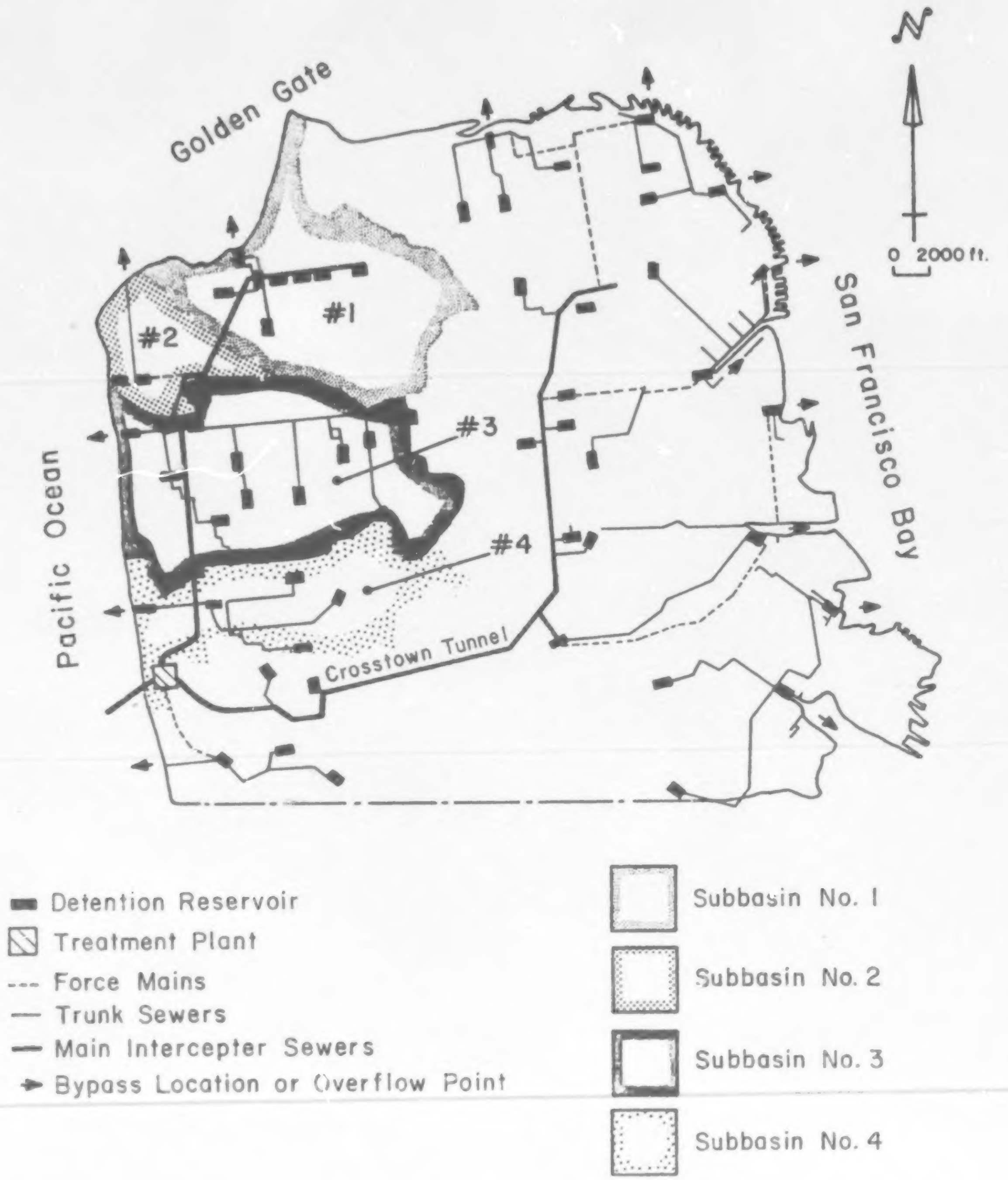


FIGURE 6

SFMPWM WITH EXAMPLE SUBBASINS DELINEATED [3]

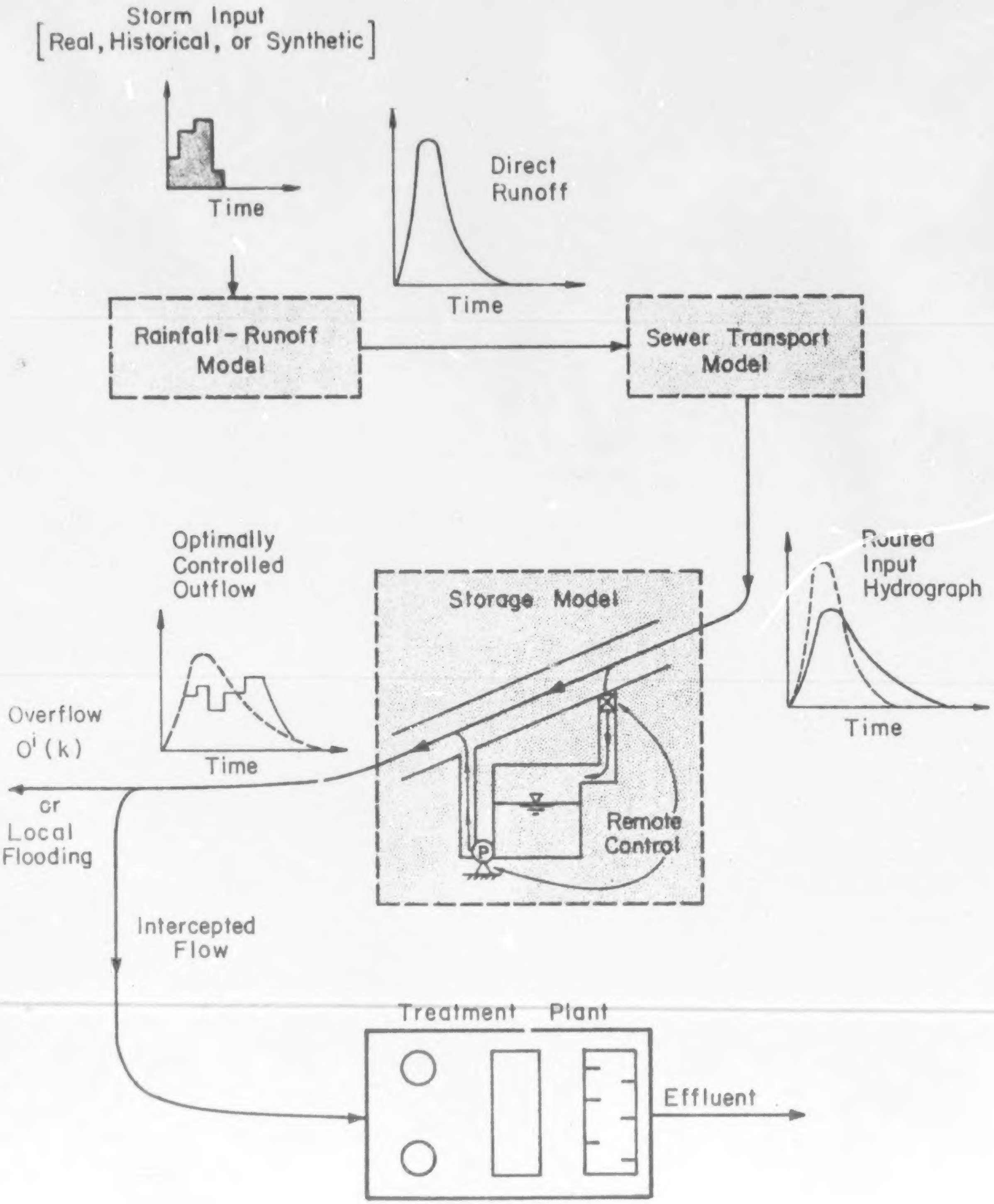


FIGURE 7

COMPONENTS OF THE AUTOMATIC CONTROL PROBLEM [3] trained in Systems Analysis, or both. As emphasized previously, consultants must be carefully chosen. Also, numerous training programs and short courses are available through several universities around the country. Video taped courses may also become available in the near future.

As to modeling and computing, there are less expensive means of getting started through use of time-sharing, minicomputers, and digital models that have already been developed. With regard to this latter point, considerable duplication of modeling effort currently exists. There is a need for processing and distributing information on available models in water-related fields. The NAR models, for example, are currently being adapted and applied to problems in other parts of the country (8).

Based on their experience with the NAR study, Schwarz and Major (8) have come to the following conclusions:

> "We are convinced...from our observation of the actions of our planning partners in the study, that the use of Systems techniques within a multiobjective framework is the way to go for water resources planning."

Water planners, however, should not make use of Systems Analysis techniques unless they are willing to get involved.

References

1. Engel, Joseph H., "The Philosophical Underpinnings of Computers and Operations Research," *Journal of Computers and Operations Research*, Vol. 1, No. 1, pp. 3-7, March 1974.

2. Giessner, W.R., R.T. Cockburn, F.H. Moss, Jr., and M.E. Noonan, "Planning and Control of Combined Sewerage Systems," *Journal of the Environmental Engineering Division*, ASCE, Vol. 100, No. EE4, pp. 1013-32, August 1974.

3. Grigg, N.S., J.W. Labadie, and H.G. Wenzel, "Metorpolitan Water Intelligence Systems," Completion Report - Phase III, MWIS Project, Colorado State University, July 1974.

4. Haimes, Y.Y. and W.A. Hall, "Multiobjectives in Water Resource Systems Analysis: The Surrogate Worth Trade Off Method," *Water Resources Research*, Vol. 10, No. 4, pp. 615-24, August 1974.

5. Major, D.C., "Impacts of Systems Techniques on the Planning Process," *Water Resources Research*, Vol. 8, No. 3, pp. 766-68, June 1972.

6. McCleod, John (ed.), "What We Must Do," *Simulation in the Service of Society*, Vol. 4, No. 5, pp. 1-2, May 1974.

7. North Atlantic Regional Water Resources Study Coordinating Committee, *Report*, *Annexes 1 and 2*, *Appendices A through U*, May 1972.

8. Schwarz, H.E. and D.C. Major,"The Systems Approach: An Experience in Planning," *Water Spectrum*, Vol. 3, No. 3, pp. 29-34, 1971.

9. Zoutendijk, G., "The Impact of Technology on Decision Making," *Journal of Computers and Operations Research*, Vol. 1, No. 1, pp. 9-13, March 1974.

SYSTEM OF ACCOUNTS AND COST ALLOCATION

Gary D. Cobb
Assistant Director, U.S. Water Resources Council
Washington, D.C.

In this presentation, we will discuss the system of public information accounts providing for the display of beneficial and adverse effects of each alternative plan on the two planning objectives and on regional development and social well-being. In addition, we shall consider how the information on beneficial and adverse effects provided in the system of public information accounts is used in the comparison of alternative plans. Two simplified illustrations of alternative plans being prepared in one ongoing Level B planning activity will be used to highlight the types of information provided for in the system of public information accounts. Finally, the cost allocation method provided for in the Principles and Standards will be illustrated.

System of Public Information Accounts

The system of public information accounts displaying beneficial and adverse effects on the national economic development and environmental quality objectives and on regional development and social well-being is to be prepared in such a manner that the different levels of achievement to each objective and effects on regional development and social well-being can be readily discerned and compared, indicating the trade-offs between alternative plans. For purposes of accounting, the distribution of beneficial and adverse effects will be shown.

Four accounts are to be used in displaying beneficial and adverse effects and for showing and analyzing the tradeoffs among alternative plans. The four accounts to be used are: (1) national economic development, (2) environmental quality, (3) regional development, and (4) social well-being. The system of accounts will also display the beneficial and adverse effects for the geographical area relevant to the evaluation of the regional development account in the planning area in relation to other parts of the nation. Thus, effects can be shown for the planning region, other regions as appropriate, and for the rest of the nation in the regional development account.

Beneficial and adverse effects on the NED objective will be shown in monetary terms. Beneficial and adverse effects on the EQ objective will be shown in appropriate quantitative units or qualitative terms and will not be shown in monetary terms. Beneficial and adverse effects in the regional development account will be shown in monetary terms for other non-monetary effects. Finally, beneficial and adverse effects in the social well-being account will be shown where appropriate in monetary terms and otherwise in appropriate quantitative units or qualitative terms.

The schematic diagram of the system of accounts indicates the structure of the four accounts including the regional structure under the regional development account (Figure 1).

NED Development Account

The national economic development account provides for displaying beneficial effects associated with the value of increased outputs for water supply, flood control, power, transportation, recreation, commercial fishing, and underemployed labor resources in construction (Figure 2). In addition, the value of external economies is to be displayed. Adverse effects associated with the value of resources required for plan implementation, plan operation and displaced labor resources and value of external diseconomies is to be displayed. Comparing total beneficial effects with total adverse effects, provides for display of net beneficial effects for the account.

EQ Account

The environmental quality account will provide for the display of beneficial and adverse effects for the following components:

- A. Physical Land Resources
    - 1. Soil stability
    - 2. Geological resources
- B. Air and Water Quality
    - 1. Air quality standards
    - 2. Water quality standards
- C. Ecological Resources
    - 1. Terrestrial ecosystems
    - 2. Aquatic ecosystems
    - 3. Special ecosystem relationships and irreversible commitments of resources
    - 4. Species threatened with extinction

Figure 1

SCHEMATIC DIAGRAM OF SYSTEM OF ACCOUNTS

Account	
NED	Beneficial and Adverse Effects
EQ	Beneficial and Adverse Effects
RD	
Region 1	Beneficial and Adverse Effects
Region 2	Beneficial and Adverse Effects
Rest of Nation	Beneficial and Adverse Effects
SWB	Beneficial and Adverse Effects

Figure 2

NATIONAL ECONOMIC DEVELOPMENT

COMPONENTS	MEASURES OF EFFECTS
BENEFICIAL EFFECTS:	
A. VALUE INCREASED OUTPUTS	
(1) WATER SUPPLY	
(2) FLOOD CONTROL	
(3) POWER	
(4) TRANSPORTATION	
(5) RECREATION	
(6) COMMERCIAL FISHING	
(7) UNEMPLOYED LABOR RESOURCES IN CONSTRUCTION	
B. VALUE OF EXTERNAL ECONOMIES	
TOTAL BENEFICIAL EFFECTS	
ADVERSE EFFECTS:	
A. VALUE RESOURCES REQUIRED	
(1) PLAN IMPLEMENTATION	
(2) PLAN OPERATION	
(3) DISPLACED LABOR RESOURCES	
B. VALUE OF EXTERNAL DISECONOMIES	
TOTAL ADVERSE EFFECTS	
NET BENEFICIAL EFFECTS	

D. Culturally Significant Resources
   1. Archeological resources
   2. Historical resources
   3. Areas of natural beauty

RD Account

The regional development account embraces several types of beneficial and adverse effects where there are major difficulties in estimating or measuring the effect. For this reason, a complete display of beneficial and adverse effects for all components in the regional development account will not be made for a plan unless directed by a Department Secretary or head of an independent agency.

The regional development account structure (Figure 3) provides for measurement of effects in the planning area other regions as appropriate and for the rest of the nation. The final incidence of beneficial and adverse effects may be shown to whomsoever they accrue illustrated in our example tables for direct users at the farm, in the city, and users of recreation. Income effects associated with the value of increased outputs for the NED components and for all unemployed or underemployed labor resources as well as additional net income resulting from location effects or transfer effects may be shown. In addition, the value of external economies may be shown providing for display of total income effects. Adverse income effects associated with value of resources required and contributed from within the region, reimbursement, loss of assistance, payment of losses for displaced labor resources, and loss of net income as well as the value of external diseconomies may be shown to indicate the total adverse income effects. Comparing total beneficial income effects with total adverse effects indicates the net beneficial income effects. Similarly, for each region under consideration and for the rest of the nation, the beneficial and adverse effects for other components of the regional development account may be shown including beneficial and adverse effects on employment, population distribution, economic base stability and environmental conditions of special regional concern. Also, the incidence of beneficial and adverse effects for the other components of the regional development account may be shown for appropriate groups or classes (Figure 4).

Figure 3

REGIONAL DEVELOPMENT

MEASURES OF EFFECTS

	REGION 1 (PLANNING AREA)					REGION 2 (ADJACENT AREA)					REST OF NATION	SUMMARY
	DIRECT USERS					DIRECT USERS						
	FARM	CITY	RECREATION	OTHER	STATE LOCAL GOVT.	FARM	CITY	RECREATION	OTHER	STATE LOCAL GOVT.		
INCOME												
BENEFICIAL EFFECTS:												
A. VALUE INCREASED OUTPUTS												
(1) NED COMPONENTS												
(2)												
(3)												
(4)												
(5)												
(6)												
(7) UNEMPLOYED LABOR RESOURCES												
ADDITIONAL NET INCOME												
B. VALUE OF EXTERNAL ECONOMIES												
TOTAL BENEFICIAL EFFECTS												
ADVERSE EFFECTS:												
A. VALUE RESOURCES REQUIRED												
REIMBURSEMENT												
LOSS ASSISTANCE												
LOSSES DISPLACED LABOR RESOURCES												
LOSS NET INCOME												
B. VALUE OF EXTERNAL DISECONOMIES												
TOTAL ADVERSE EFFECTS												
NET BENEFICIAL EFFECTS												

Figure 4

REGIONAL DEVELOPMENT (Continued)

COMPONENTS	MEASURES OF EFFECTS		
	REGION 1	REGION 2	REST OF NATION
EMPLOYMENT			
BENEFICIAL EFFECTS			
ADVERSE EFFECTS			
POPULATION DISTRIBUTION			
BENEFICIAL EFFECTS			
ADVERSE EFFECTS			
ECONOMIC BASE STABILITY			
BENEFICIAL EFFECTS			
ADVERSE EFFECTS			
ENVIRONMENTAL CONDITIONS OF SPECIAL REGIONAL CONCERN			
BENEFICIAL AND ADVERSE EFFECTS			

Formulation Region

With respect to the region as used in formulation and evaluation, turn now to another aspect of planning, and address an issue that frequently occurs. Questions are often asked as to what are "regions" in this planning process? What is the context and the meaning of the "region"? What is the size of the "region", and so forth. One way to help facilitate thinking about this is to break down what we're thinking in terms of "region". First of all, we can think about a "formulation region" which covers a resource base which is a supply concept. The resource base is considered in formulating alternative plans to manage the natural resources of a particular planning setting. All alternative plans should deal with the same basic set of resources. Thus, we deal with the resource base in formulation of alternative plans and that represents one concept of "region".

Another concept of "region" is addressed in formulation dealing with demands. Where are these demands that we're managing resources to serve? Such demands may be flood control downstream representing a formulation region to deal with flood control demand. Another formulation region may be considered in dealing with recreation and power demand. Similarly, a third formulation region may be considered in dealing with M&I (municipal and industrial) water supply, a demand concept. Thus, regions may be thought about in the above context, in terms of considering supply and demand in formulation of alternative plans.

Evaluation Regions

Evaluation regions are another concept of "regions". Evaluation regions may be any "region" or set of "regions" appropriate for evaluation. The Principles and Standards suggest that the evaluation region encompassing the planning area ought to be large enough so that it encompasses the principal effects of all of the alternative plans. Thus Region 1, Evaluation Region 1, should encompass all the major effects (Figure 5).

Other evaluation regions as appropriate and the rest of the nation may be considered in evaluation of the beneficial and adverse effects on components of the regional development account (Figures 6 and 7).

Figure 5

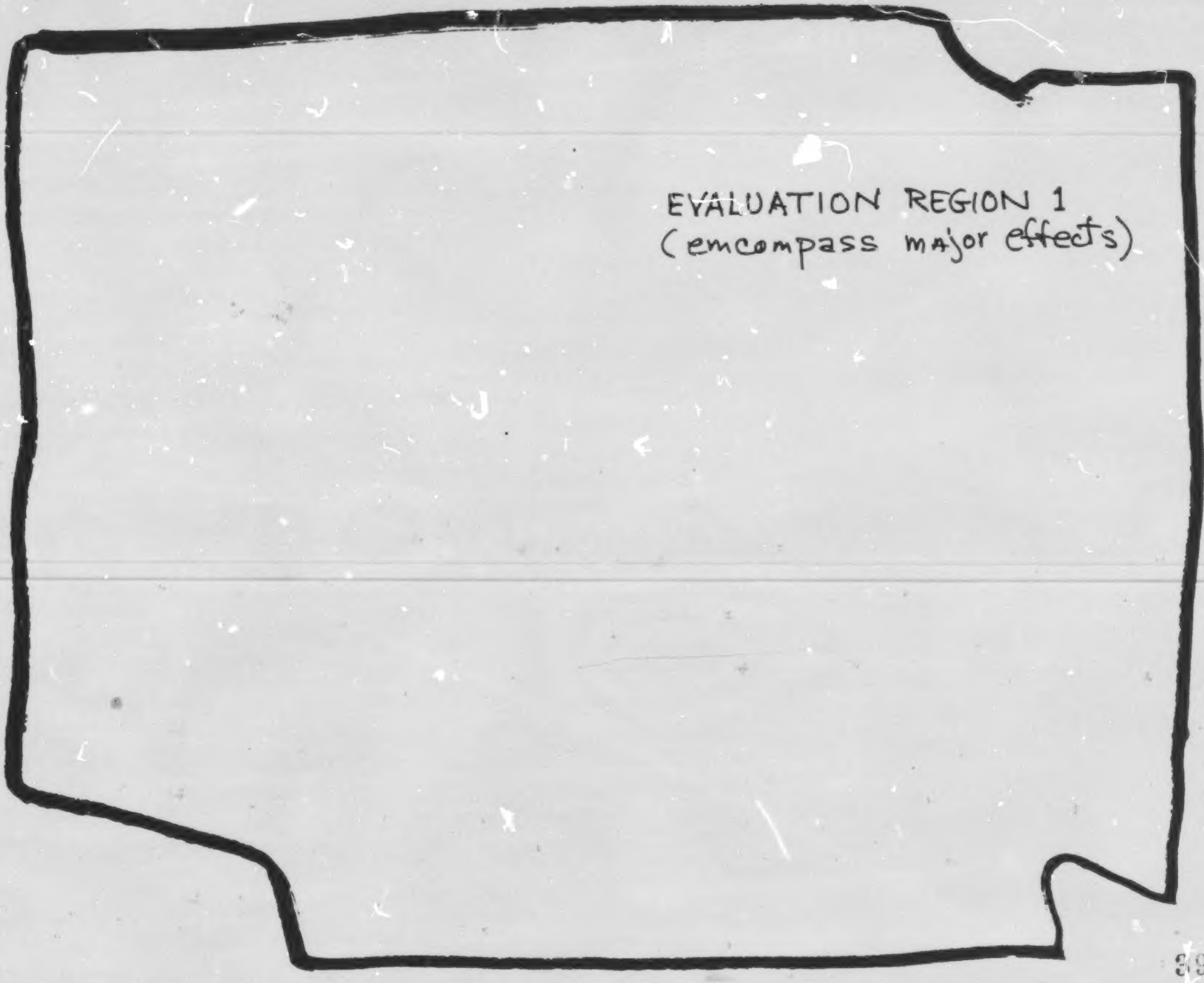


Figure 6

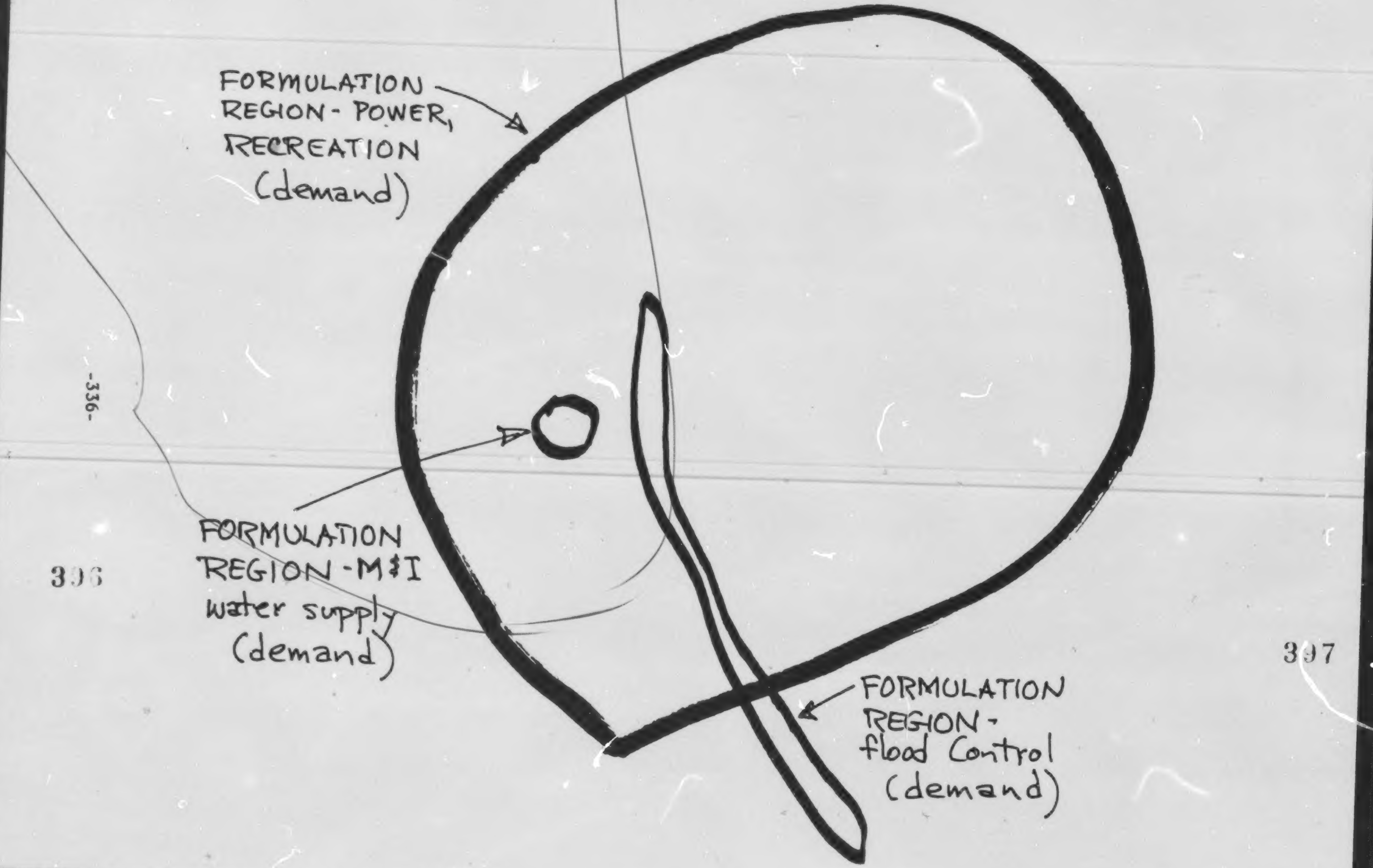
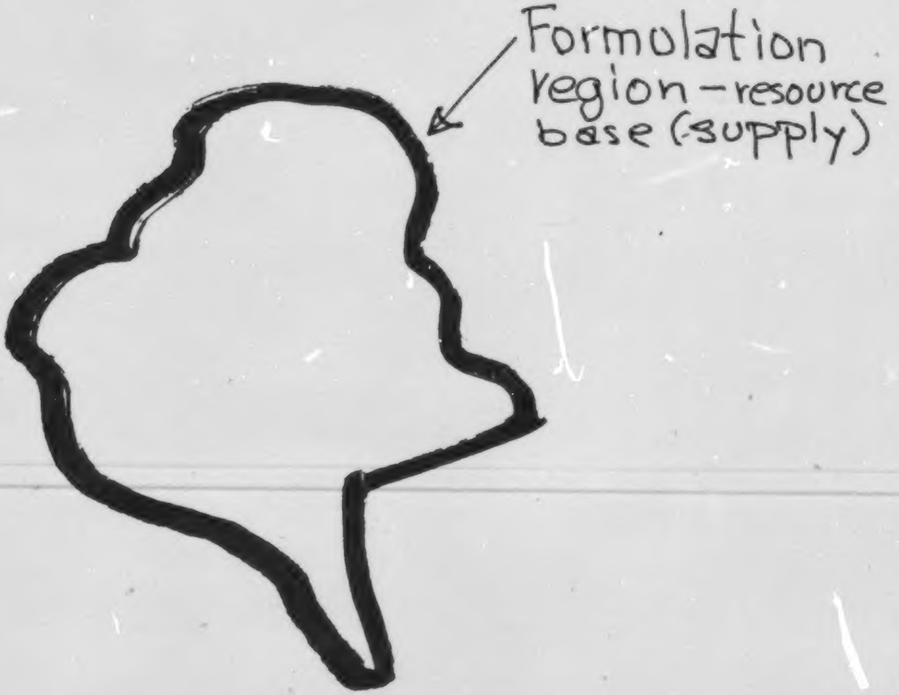

FORMULATION REGION - POWER, RECREATION (demand)
FORMULATION REGION - M&I water supply (demand)
FORMULATION REGION - flood Control (demand)
396
397

Figure 7



SWB Account

The social well-being account would display beneficial and adverse effects on real income distribution; life, health, and safety; educational, cultural and recreational opportunities; emergency preparedness and other relevant components (Figure 8).

Comparison of Alternative Plans in the Beneficial and Adverse Effects of the Four Accounts

Shown is a summary comparison of two alternative plans illustrating the comparison of beneficial and adverse effects in the four accounts for one alternative Plan B and the recommended Plan A. The difference or trade-off is indicated by the comparison of the beneficial and adverse effects of Plan A minus the beneficial and adverse effects of Plan B. It is very important that the trade-offs always be determined in this matter so that the net positive and net negative effects are not at times reversed. This second series of displays will be used to provide a ready comparison of alternative plans. Each of the alternative plans is to be paired with the recommended plan so that the advantages or disadvantages of each can be compared. Other comparisons between alternative plans may be displayed where relevant. The information needed for this second series of displays will be taken from the first series of displays showing, where appropriate, the gross beneficial and gross adverse effects and net beneficial effects for the four accounts. The information should be summarized and condensed to make it as brief and yet as meaningful as possible Finally, in presenting the tradeoffs in summary form to decision-makers it may be appropriate to only show those key trade-offs that are significant in the selection of one particular alternative plan over another in order to focus and insure the decision-making process addresses the crucial issues (Figure 9).

Simplified Alternative Plans for River Basin (Level B)

Simplified alternative plans have been taken from a regional or river basin planning activity (Level B) presently underway.

The first Level B shown is an alternative plan emphasizing the NED objective (Figure 10). The plan provides for four main stem reservoirs providing water supply and irrigation on an Indian reservation and elsewhere, fish and wildlife, cooling water for thermal plants and flood protection with reduced flows to the adjacent down stream state. The second Level B plan shown is another alternative plan emphasizing the EQ objective (Figure 11). This plan

Figure 8

SOCIAL WELL-BEING

Components	Measures of Effects
Beneficial and Adverse Effects:	
A. Real Income Distribution	
B. Life, Health and Safety	
C. Educational, Cultural, Recreational Opportunities	
D. Emergency Preparedness	
E. Other	

Figure 9

SUMMARY COMPARISON OF TWO ALTERNATIVE PLANS

Account	Plan B	Recommended Plan A	Difference, Tradeoff (Plan A Minus B)
NED			
Beneficial Effects			
Adverse Effects			
Net Beneficial Effects			
EQ			
Beneficial and Adverse Effects			

	Plan B	Recommended Plan A	Difference, Tradeoff (Plan A Minus B)
RD			
Region 1			
Beneficial and Adverse Effects			
Region 2			
Beneficial and Adverse Effects			
Rest of Nation			
Beneficial and Adverse Effects			
SWB			
Beneficial and Adverse Effects			

Figure 10

Alternative Plan Emphasizing NED

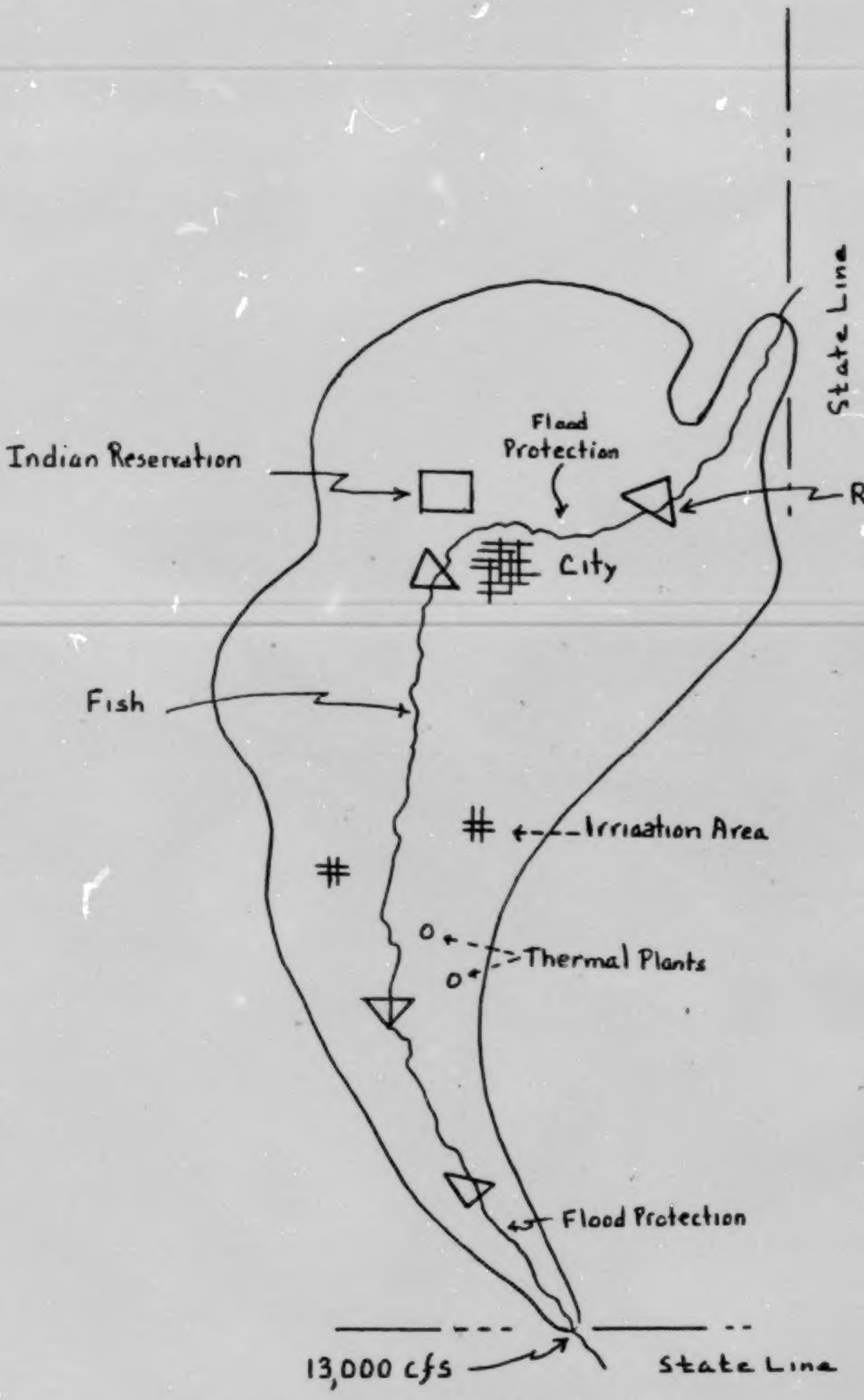
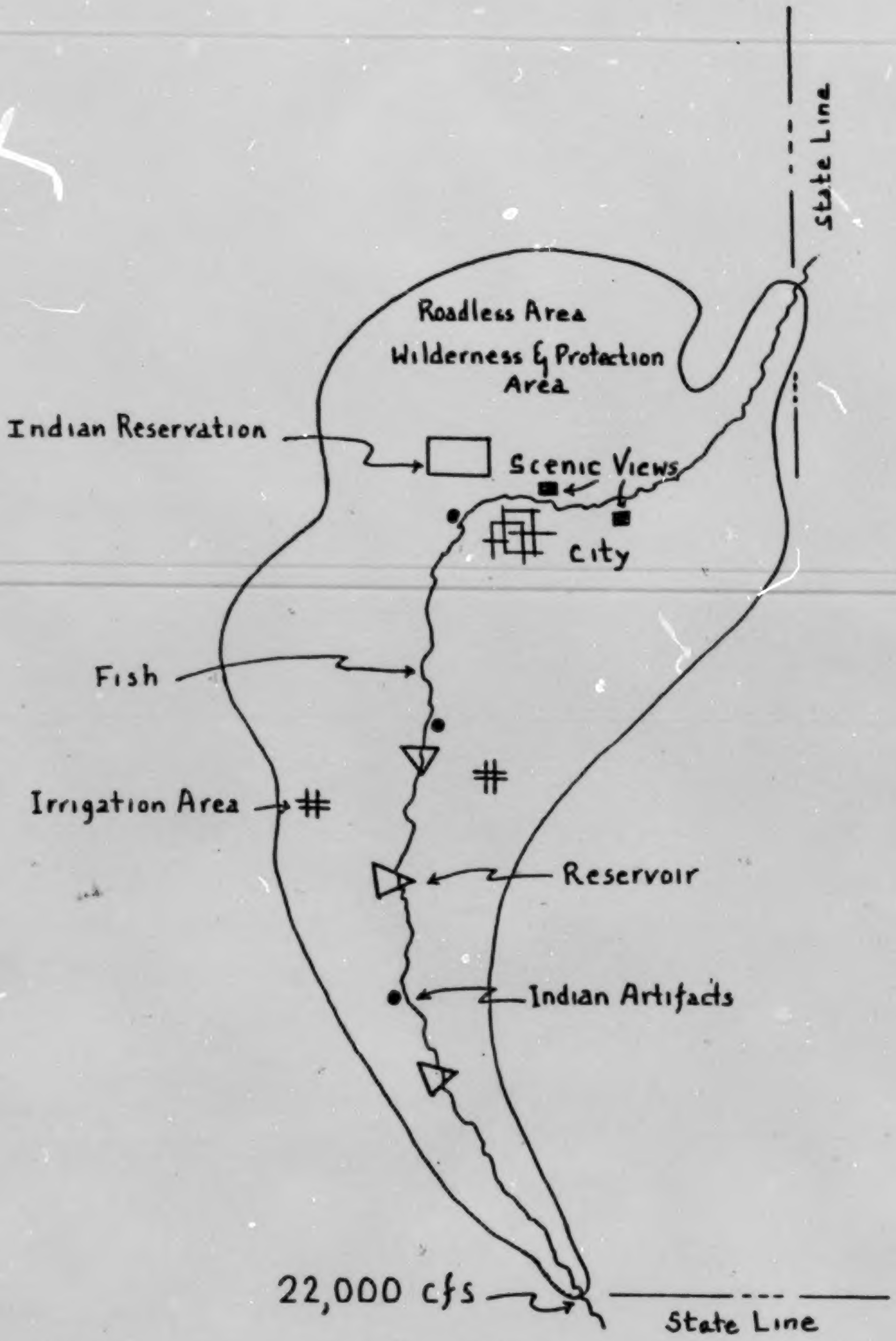


Figure 11

Alternative Plan Emphasizing EQ



403

provides for designation of a wilderness area/preservation area, scenic vistas, three smaller main stem reservoirs all located down stream with reduced supplies for irrigation on an Indian reservation and other irrigation with increased suuplies for fish and wildlife, ecological systems and flows to the adjacent down stream state, along with preservation of important Indian artifacts and archeological resources.

This illustrates how the system of public information accounts could be very useful in comparing beneficial and adverse effects of these two alternative Level B plans.

Cost Allocation

The cost allocation method when dealing with the two objectives becomes a two stage process involving first the allocation of cost between objectives and then the further allocation of costs among components of objectives. The system of accounts showing beneficial and adverse effects for alternative plans, will usually provide much of the information needed in this process.

For cases when features of a plan are included to serve the environmental quality objective and at the same time contribute incidentally to the national economic development objective as illustrated in Case One (Figure 12), the method provides that the net incremental costs of such features be allocated to the EQ objective. In our illustration for Case One, the net incremental NED costs of Plan B equals $20 which is allocated to the EQ objective. This net amount reflects an increase in costs incurred for the environmental quality increment of $40 with incidental beneficial contributions of $20. This results in a net incremental NED cost of $20. The total costs of the recommended plan of $90 minus the $20 allocated to the EQ objective results in costs of $70 of Plan B allocated to the NED objective.

The second stage of the cost allocation method provides for the further allocation of NED costs among components of the NED and EQ objectives. For the NED objective this is done essentially through application of the separable costs-remaining benefits method of cost allocation previously used. The first step provides for the identification of the separable NED costs for the NED components and is done by omitting from the recommended plan each NED component in turn. The cost of the plan with each component in turn omitted,

Figure 12

ALLOCATION OF NED COSTS BETWEEN OBJECTIVES

Case 1

	NED Plan A	Recommended Plan B	Difference
NED Objective			
Benefits	$100	$120	$ 20
Costs	50	90	40
Net Benefits	$ 50	$ 30	$-20

Net incremental NED costs (of Plan B) = $20 allocated to EQ objective

$90-20 = $70 costs of Plan B allocated to NED objective

405

when compared with the total NED costs of the plan, provides for the identification of separable NED costs for each component (Figure 13).

Remaining joint NED costs of the NED objective are then determined by subtracting total separable costs from the total costs allocated to the NED objective. Under the separable costs-remaining benefit method of cost allocation, separable costs are first allocated to each NED component. In our illustration these separable costs are $10 for flood control, $5 for recreation, and $25 for power (Figures 13 and 14). Remaining joint costs, in this case $30, is allocated proportional to the difference between the separable costs allocated to each component and alternative costs indicated as AC or benefits indicated as B, whichever is lesser for each NED component (Figure 15).

Note that in the case of flood control, it is assumed that alternative costs would be less than the benefits and thus limit the allocation to that component. In the case of recreation, the benefits are assumed to be less than the alternative costs for that component and would limit the allocation; and finally, in the case of power, the alternative costs are assumed to be less than the benefits for power and thus limit the allocation of costs to that component.

The allocation of NED costs among components of the EQ objective is to be made proportional to the respective alternative costs for each component.

For cases when features of a plan are designated to serve the EQ objective at the loss of net beneficial effects on the components of the national economic development objective, as illustrated in Case Two (Figure 16), the method provides that costs equivalent to the net national economic development beneficial effects foregone be allocated to the EQ objective.

As illustrated in Case Two (Figure 16), the net national economic development benefits foregone ($30-$20) with implementation of recommended Plan C are $10 composed of a decrease in benefits of $20 offset in part by a decrease in costs of $10 resulting in the net incremental NED costs of Plan C of $10 to be allocated to the EQ objective. The total costs, $80 of Plan C minus $10 results in $70 costs of Plan C allocated to the NED objective. These costs would be further allocated among the components of the NED objective using the method previously described for Case One and which is essentially the

Figure 13

ALLOCATION OF NED COSTS AMONG COMPONENTS OF THE NED OBJECTIVE

Case 1

Separable NED Costs for NED Components

	Plan B	Plan B w/o FC	Plan B w/o Rec	Plan B w/o Power
Total NED Costs	$90	$80	$85	$65

	Separable NED Costs
FC	$10
Rec	5
Power	25
	$40

Remaining Joint NED Costs of NED Objective

NED Costs Allowed NED Objective ($90-20)	$70
Separable NED Costs	-40
	$30

407

Figure 14

ALLOCATION NED COSTS AMONG NED COMPONENTS

Case 1

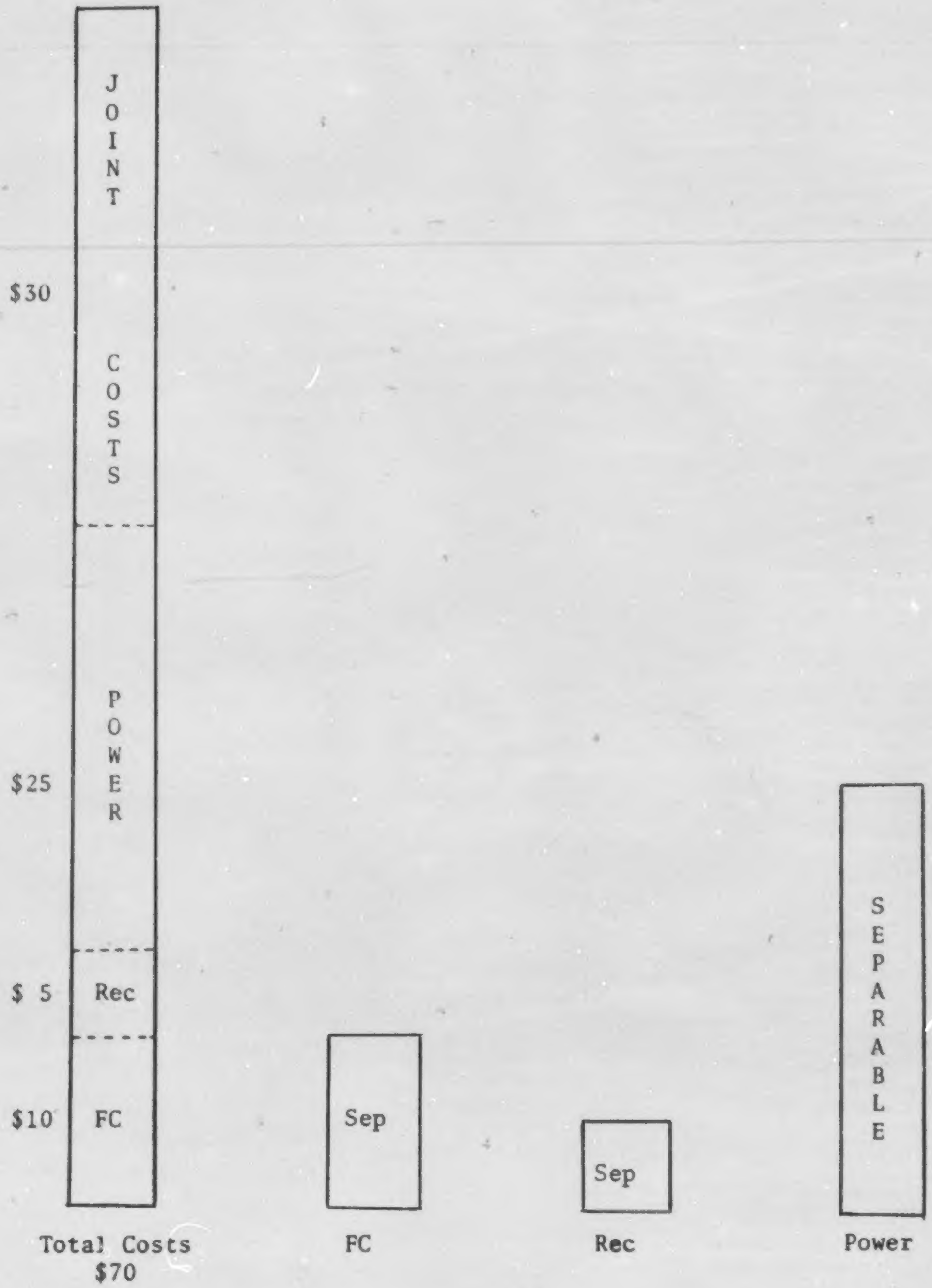
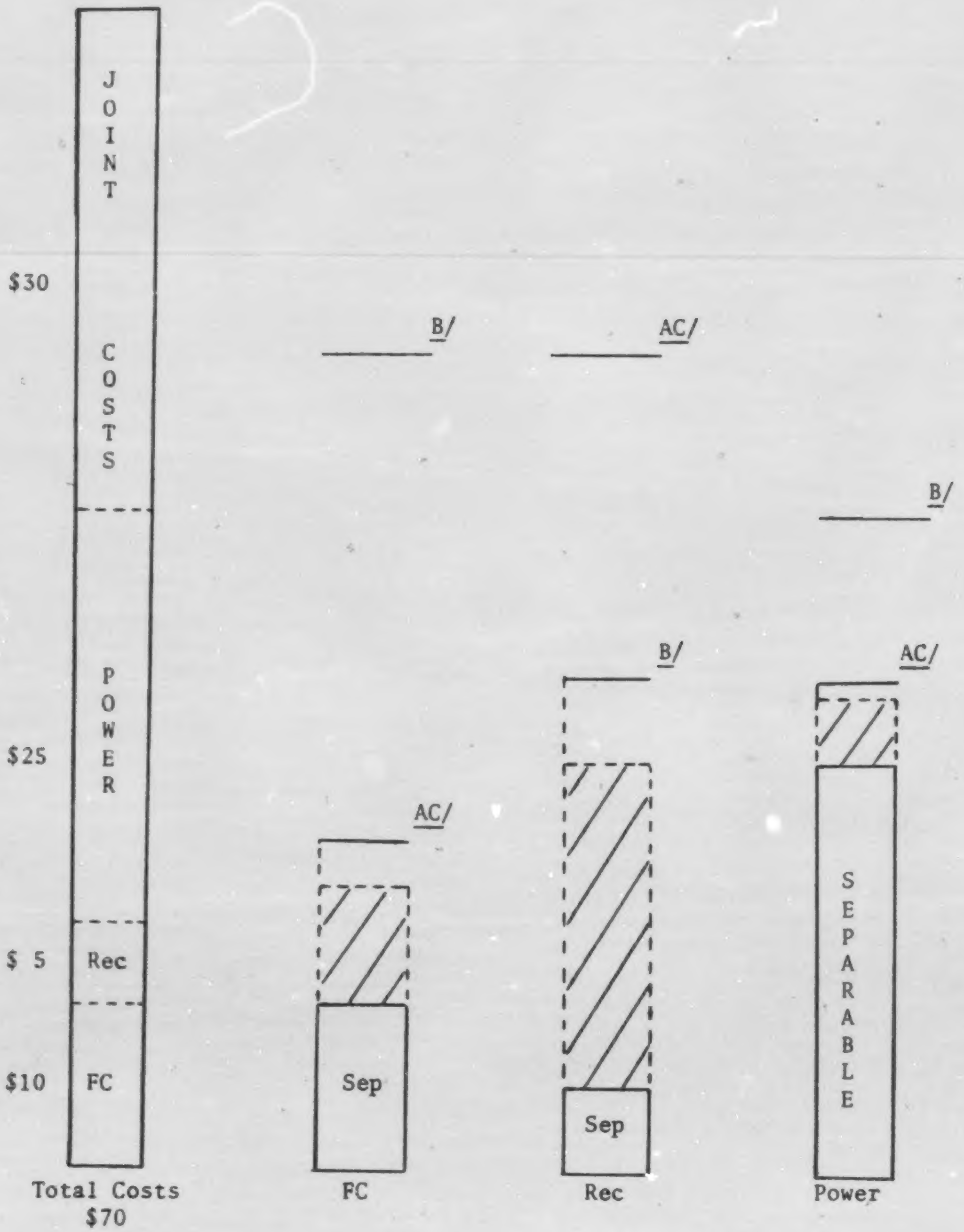


Figure 15

ALLOCATION NED COSTS AMONG NED COMPONENTS

Case 1



409

Figure 16

ALLOCATION OF NED COSTS BETWEEN OBJECTIVES

Case 2

	Service to EQ Objective Deleted	Recommended Plan C	Difference
NED Objective			
Benefits	$120	$100	$-20
Costs	90	80	-10
Net Benefits	$ 30	$ 20	$-10

Net incremental NED costs (of Plan C) = $10
allocated to EQ objective

$80 - 10 = $70 costs of Plan C allocated to NED objective application of the SCRB method as used in the past. NED costs allocated to the EQ objective would be further allocated among EQ components proportional to the respective alternative costs for such components.

Two of the member agencies of the Water Resources Council have expressed concern about the implementation of the cost allocation method described above. The Council has agreed to undertake further review of the cost allocation method described above to determine what if any exceptions might be made for specific circumstances in the application of the method. Particular concern has been expressed in certain circumstances about the appropriateness of the method for Case Two illustrated above involving cases when features of a plan are designated to serve the EQ objective at the loss of net beneficial effects on components of the NED objective.

Conclusion

The system of public information accounts providing for a systematic display of beneficial and adverse effects including those which are generally regarded as favorable or beneficial as well as those which are generally regarded as unfavorable or adverse and those for which preferences differ and may be considered either beneficial or adverse depending on the value judgments or those expressing the preferences, should contribute significantly to the decision-making processes and in the management of the Nation's water and related land resources.

RIVER BASIN SIMULATION FOR PLANNING

Robert W. Hill
Agricultural and Irrigation Engineering Department
Utah State University

Preface

The following text is in the outline form of the dual screen slide-lecture presentation made at the training session August 16, 1974. The numbers in parenthesis indicate the sequence numbers of the various slides, i.e. a sequence number shown as (L4) indicates the fourth slide on the left side of the screen. The actual text of the slide is shown in capital letters with comments given in regular type.

(L1) RIVER BASIN SIMULATION FOR PLANNING

In this presentation river basin simulation means the formulation of mathematical expressions into a computer model of a given hydrologic system and the use of such a model to simulate real world effects. I feel that simulation has a lot to offer as a planning aid in the application of the Principles and Standards particularly in evaluating the effects of alternative courses of action in complex river basin systems.

(L2) MODEL TYPES

If we consider for a moment we are probably familiar with models of all kinds:

(1) 1. SMALL SIZE LOOK-ALIKE ONLY VERSION OF REAL THING
A plastic scale model airplane, or a miniature house, is a good example of this.

(2) 2. SMALL SIZE SIMILAR IN LOOKS AND PERFORMANCE TO REAL THING
Flying model airplanes (particularly radio controlled) are good examples here.

(3) 3. PERFORMANCE SIMILAR TO REAL THING IN SOME ESSENTIAL ASPECT
This encompasses a variety of models; analog models of ground water systems, digital computer models, and mathematical

expressions. The computer model of the Bear River fits in this category in that it performs like a real world hydrologic system in the sense of maintaining continuity of mass.

(L3) WHY MODEL?

Here are eight reasons:

(4) 1. A MODEL PROVIDES A BASIS FOR COORDINATING INFORMATION AND THE EFFORTS OF PERSONNEL ACROSS A BROAD SPECTRUM OF SCIENTIFIC DISCIPLINES.

(5) 2. A MODEL APPROACH REQUIRES A CLEAR IDENTIFICATION OF PROBLEMS AND OBJECTIVES ASSOCIATED WITH THE SYSTEM BEING EXAMINED.

(6) 3. INSIGHT INTO THE SYSTEM BEING STUDIED IS INCREASED. IN PARTICULAR, THE RELATIVE IMPORTANCE OF VARIOUS SYSTEM PROCESSES AND INPUT FUNCTIONS IS SUGGESTED.

(7) 4. PRIORITIES ARE INDICATED IN TERMS OF PLANNING OBJECTIVES AND DATA ACQUISITION.

(8) 5. A MODEL IS CAPABLE OF INDICATING IN QUANTITATIVE TERMS PROGRESS TOWARD SYSTEM DEFINITION AND CONCEPTUAL UNDERSTANDING.

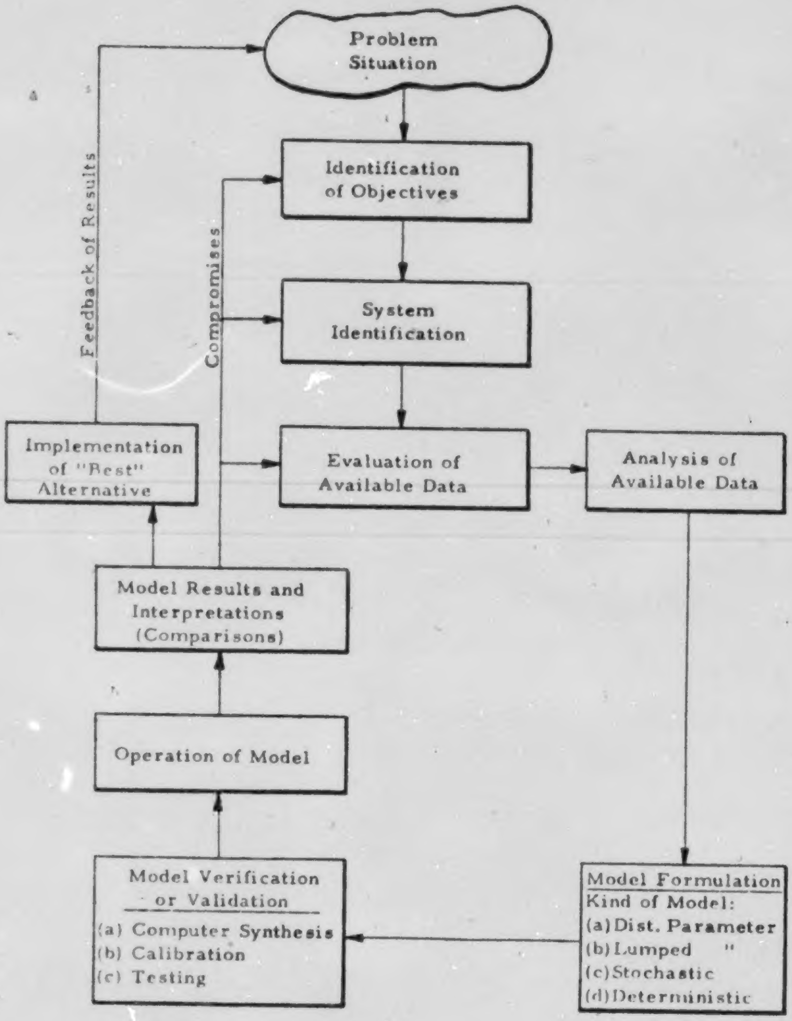
(9) 6. PROPOSED MODIFICATION OF EXISTING SYSTEMS CAN BE NON-DESTRUCTIVELY TESTED.

(10) 7. MANY PLANNING AND MANAGEMENT ALTERNATIVES AND PROPOSALS CAN BE STUDIED WITHIN A SHORT TIME PERIOD.

(11) 8. HYPOTHETICAL SYSTEM DESIGNS CAN BE TESTED FOR FEASIBILITY OR COMPARISON WITH ALTERNATIVE SYSTEMS.

(L4) MODELING STRATEGY

A schematic diagram of the steps involved in a simulation study is given in Figure 1.



(12) Figure 1. Steps in the development and application of a simulation model.

As you may note, the process of modeling could become a continuous effort with continual feedback and improvement of the model. From a practical viewpoint at some level of development, this continuous process must be terminated and the model used as a total for examining planning alternatives, with the understanding that it is the "best we can do at the present". Let us now consider some of the component boxes in Figure 1.

(L5) IDENTIFICATION OF OBJECTIVES

(13) 1. WHAT ARE THE SOCIAL OBJECTIVES OF SYSTEM MANAGEMENT:

. IRRIGATION
. MUNICIPAL AND INDUSTRIAL
. RECREATION
. OTHER

(14) 2. WHAT PROBLEMS AND IMPACTS ARE APT TO BE CREATED BY SYSTEM MANAGEMENT?

(L6) SYSTEM IDENTIFICATION

System identification means the selection of pertinent processes from the real world which are essential for proper simulation. As we examine the real world we do not fully comprehend all that occurs there. Thus a certain amount of detail has been lost to our perceived image, as in a filtering process.

(L7) (Scenic slide of the Logan River, the real world)

(15) (Figure 2, representation of the real world)

(16) (Figure 3, filter loss: real world to conceptual model) This leads to a conceptual model which lacks some of the irregularities of the real world.

Figure 2. Representation of the real world.

Figure 3. Filter loss: Real world to conceptual model.

(L8) (Figure 4, pictoral of conceptual model).

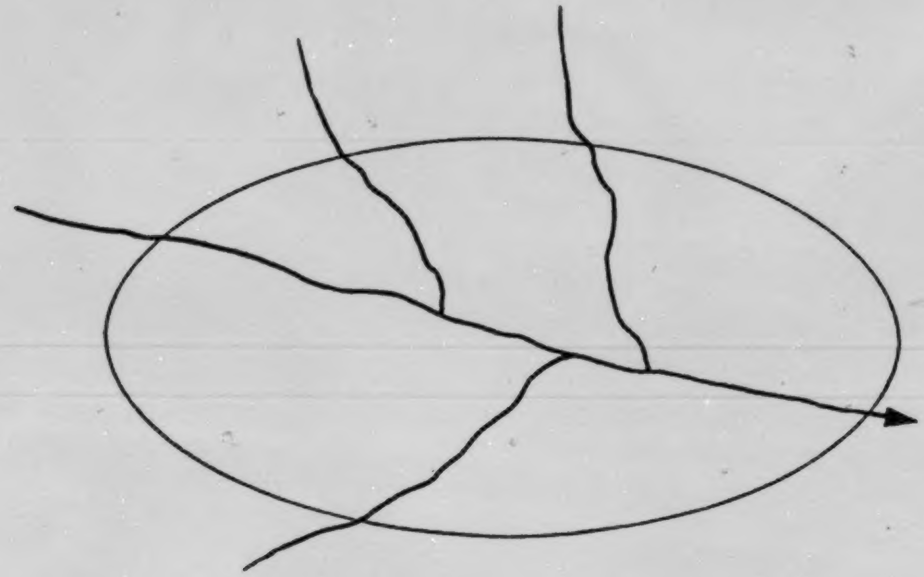


Figure 4. Pictoral of Conceptual Model.

(17) (Figure 5, representation of conceptual model) Going on from the conceptual model further description of the real world is generally done via mathematical expressions. Thus, another filter loss occurs before the working model is arrived at.

(18) (Figure 6, filter loss: Conceptual to working model)

(19) (Figure 7, representation of working model) A working model could be an equation.

(L9) MATHEMATICAL EXPRESSION

Typical hydrologic models in simple equations are:

(L10) RUNOFF = C X RAIN

(L11) Q = CIA

Many of you will recognize this as the "rational" equation for peak runoff from small watershed.

Figure 5. Representation of conceptual model.

Figure 6. Filter loss: Conceptual model to working model.

418

Figure 7. Representation of working model.

(L12) Q = (PPT - INF - DPS - ET) dT

This equation states that the runoff rate is equal to the integral of the supply rate (PPT) minus the rate of abstractions. Expressions of this type form the basis for computer models of storm runoff.

(L13) COMPUTER MODELS

(114) (Figure 8, Flow Chart of a Computer Model)

Each of the boxes in Figure 8 represent a storage element in the real system, with the lines being connecting or linkage processes described by appropriate equations.

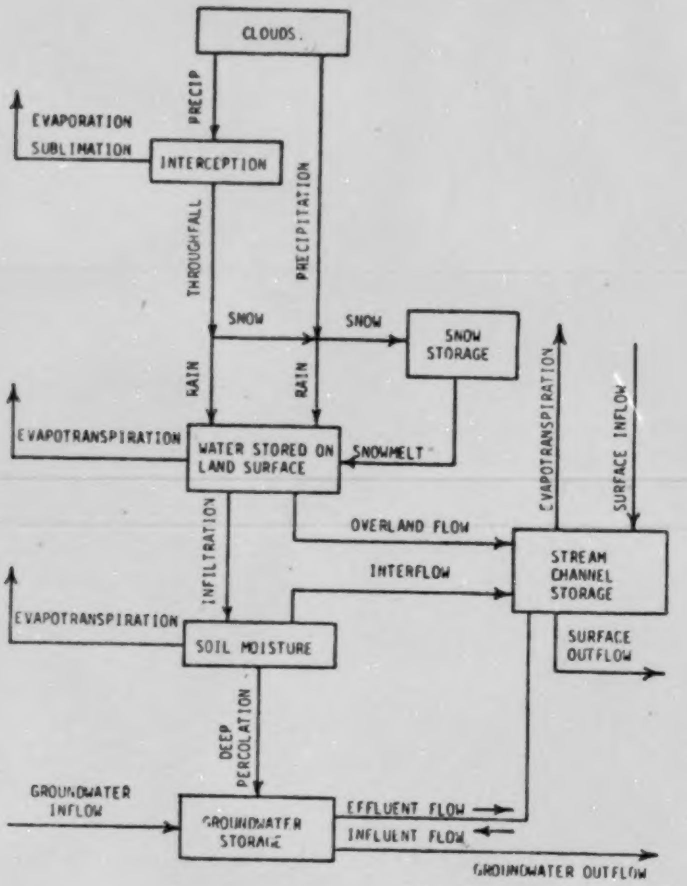


Figure 8. Schematic diagram of a generalized Hydrologic model.

(L15) EVALUATION AND ANALYSIS OF DATA.

(20) 1. DATA POINTS ARE "WINDOWS" THROUGH WHICH WE OBSERVE OR SEE THE SYSTEM.

(21) 2. DATA ENABLE US TO EVALUATE MODEL PERFORMANCE IN TERMS OF THE REAL WORLD.

There is no point in developing a five minute time interval model if all you have is daily precipitation data. The size of the problem determines the required resolution of the data. For example, the design of an irrigation storage reservoir could be done with monthly average data, but the design of the parking lot drain would require individual storm rainfall patterns at much shorter time intervals with smaller space increments as well.

(22) 3. DATA ENABLE US TO EVALUATE MODEL PERFORMANCE IN TERMS OF THE REAL WORLD.

It is very important that the model's credibility be established before it is used in planning exercises.

(23) 4. DATA RELIABILITY DETERMINES MODEL ACCURACY

In summary, the collection and use of field data is an essential part of a modeling program. In many instances, the development of a model up through the conceptual stage can aid in identifying locations and frequency of field data points for adequate real world system description to support the desired goals of a planning activity.

(L16) MODEL FORMULATION

The discussion for the rest of the presentation is directed toward the modeling exercise on the Bear River System of Utah, Wyoming and Idaho. The following slides give an indication as to what the Bear River System looks like.

(L17) (Slide of Gaging Station 10 - 115; Bear River nr. Utah - Wyoming State Line)

Notice the crystal clean water, with quite a low TDS.

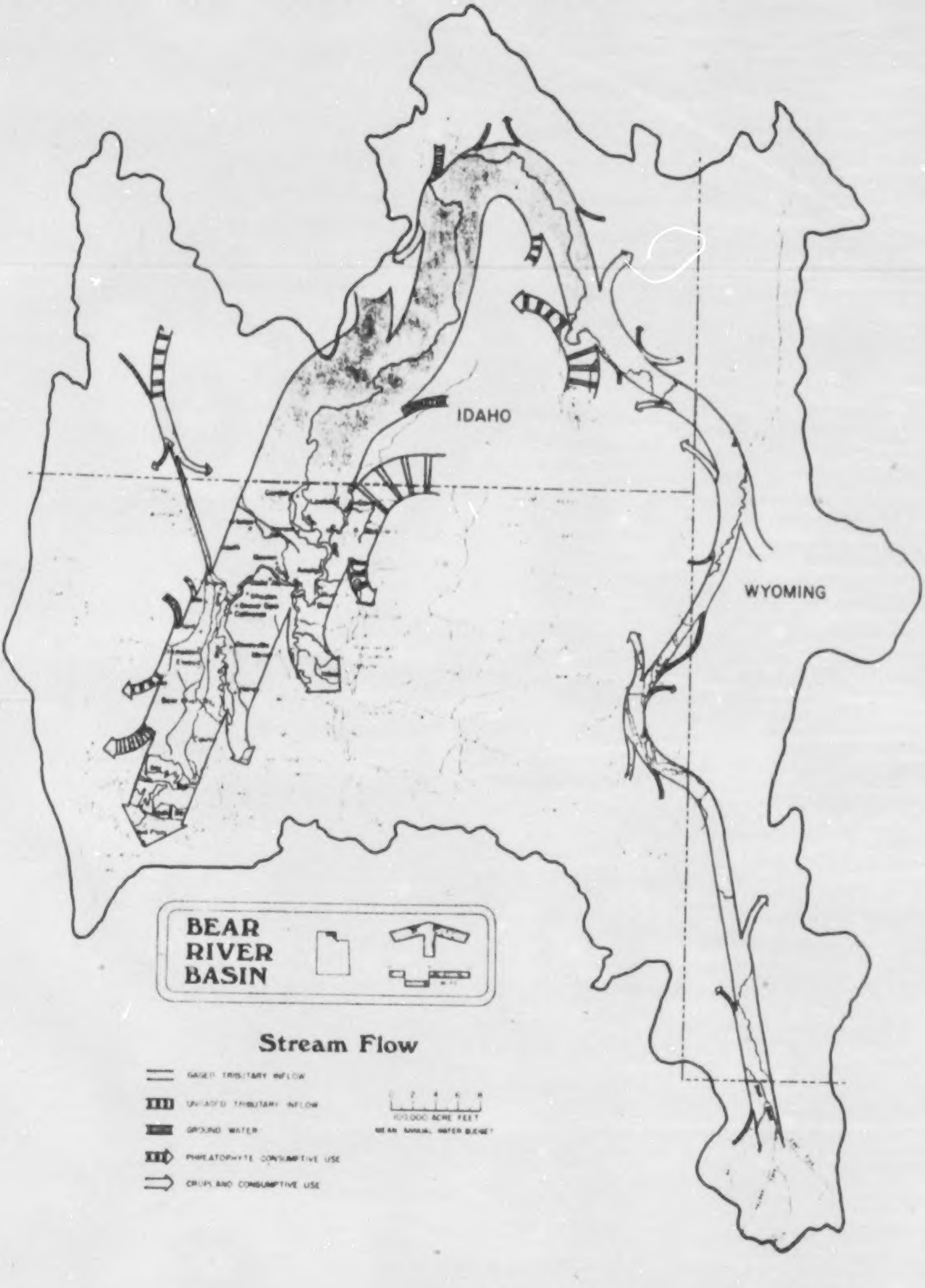


Figure 9. Surface flow diagram of mean annual water budget for the Bear River drainage area.

(L18) (Slide of gaging station 10-320; Smiths Fork near Border, Wyoming)

A typical tributary of the Bear River. Again we see good quality water.

(L19) (Slide at gaging station 10-795; Bear River at Alexander, Idaho)

A change in water quality from the previous slides is quite noticeable here as the water is a muddy color.

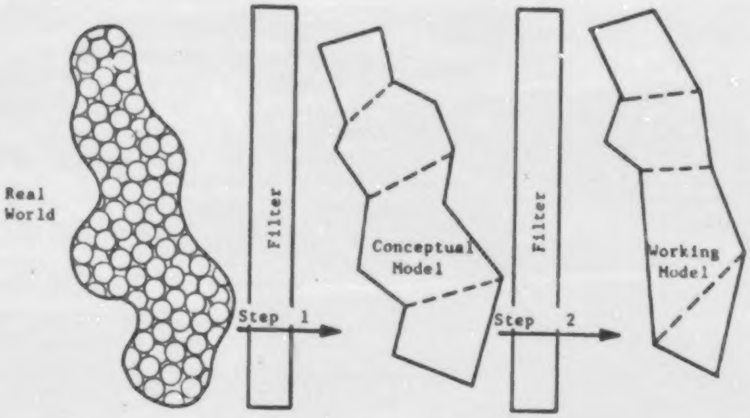
(L20) (Figure 9, Bear River surface flow diagram map)

Water management of Bear River System could be quite a tricky situation politically because of the manner in which the river flows from Utah into Wyoming, into Utah, back into Wyoming, to Idaho and finally into Utah where it terminates in the Great Salt Lake.

In formulating the model of the Bear River System, we were trying to accomplish the following:

(24) STEP BETWEEN THE CONCEPTUAL MODEL AND THE WORKING MODEL

This is illustrated at Step 2 in Figure 10.



(25) Figure 10. Steps in the development of a model of a real world system.

The conceptual model is represented in pictoral form by Figure 11.

(L21) (Pictoral of Conceptual Model, Figure 11).

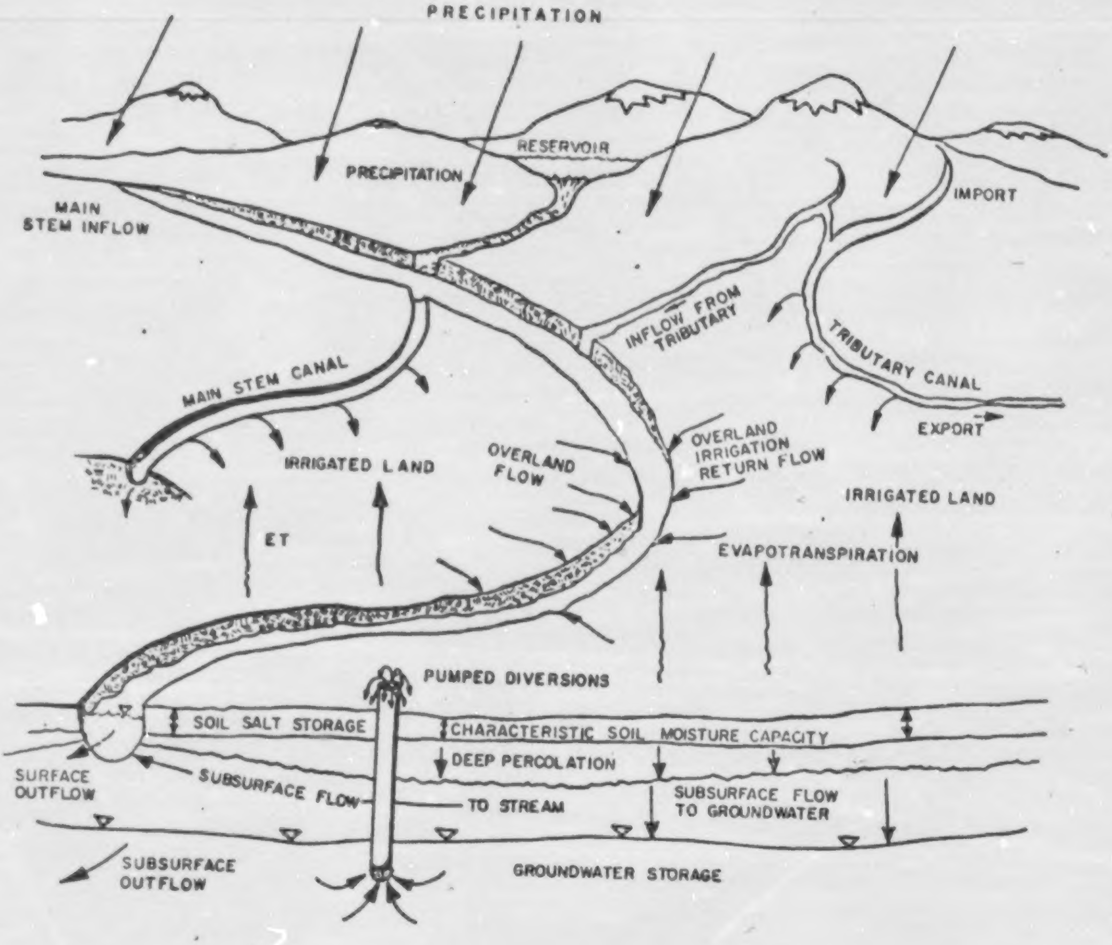


Figure 11. Pictoral representation of a typical subbasin in the Bear River System.

The model is based on the principle of continuity of mass as expressed by the following form of the Hydrologic Equation:

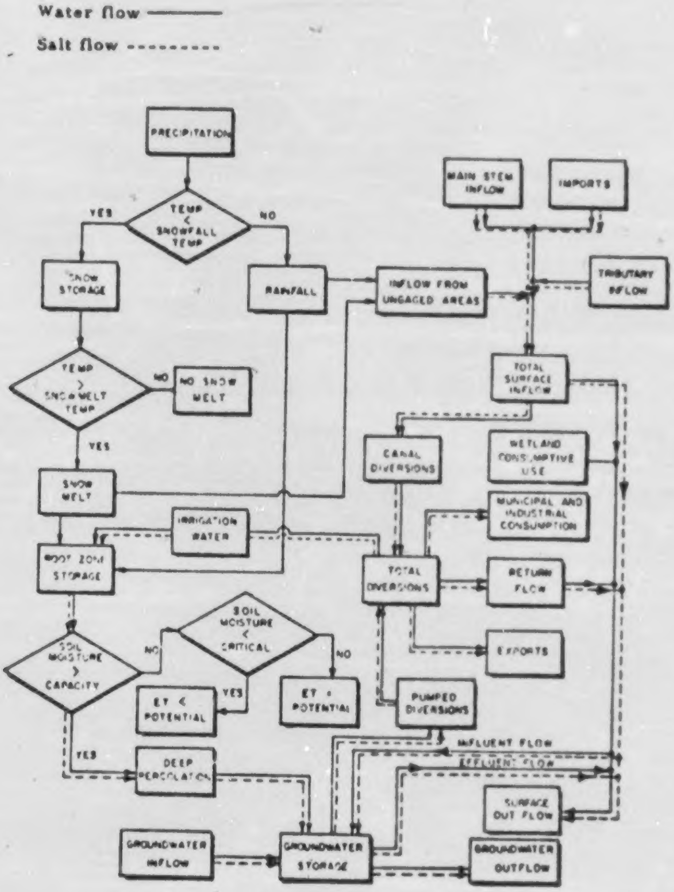
(L22)

$$(PPT + QSI + QGI) - (ET + QSO + QGO) = \Delta S.$$

in which

PPT = precipitation on the area
QSI = total surface inflow
QGI = subsurface inflow
ET = evapotranspiration from the area
QSO = total surface outflow
QGO = subsurface outflow
ΔS = change in water storage including snow, soil moisture, surface reservoirs, and groundwater

This equation (and others) were then translated into the computer model as represented by the flow chart given in Figure 12.



(L23) Figure 12. Schematic diagram of the hydro-salinity model.

Some additional considerations in the model formulating process are:

(26) MODEL COMPLEXITY IS LARGELY A FUNCTION OF MODEL RESOLUTION IN THE TIME AND SPACE DIMENSIONS.

The shorter the time increment with corresponding smaller space units requires more complex models with attendent data requirements.

(27) MODEL RESOLUTION IS DETERMINED BY THE PROBLEM REQUIREMENTS (OBJECTIVES) AND AVAILABLE DATA.

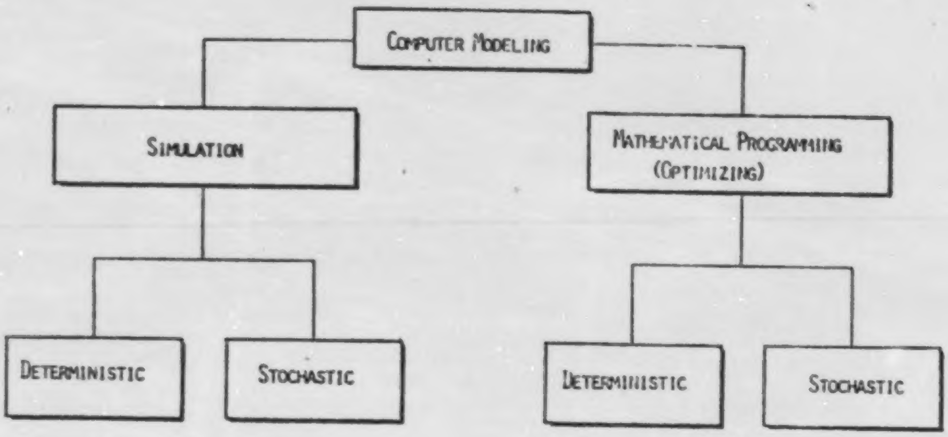
It is quite unlikely that a model which is adequate for sizing an irrigation storage reservoir would have the fine scale resolution to generate individual storm runoff hydrographs at 15 minute intervals.

(28) TWO BASIC CATEGORIES FOR MODEL RESOLUTION ARE:

(A) LUMPED PARAMETER

(B) DISTRIBUTED PARAMETER

In a lumped parameter model of the Bear River Basin as an example, the average irrigation efficiency for the entire basin would be about 40 per cent (conveyance and application). Whereas, in a distributed parameter model the irrigation efficiencies pertinent to particular subareas would be used. The model we developed is sort of a combination. For a given subbasin, the average value of a parameter is distributed through the use of several different subbasins in the entire river basin. The same basic model is used for each subbasin. The data particular to a given subarea is the determining factor for identifying parameter values which describe that subarea. There are two basic model categories as illustrated by Figure 13.



(29) Figure 13. Two basic model categories.

The model of the Bear River system is a deterministic simulation model. It is deterministic in the sense that historical data was used by the model to determine what the response would have been if certain conditions had been imposed on the river system in the past. This is sometimes called the "what if" type of question. The model can estimate the river system response to such items as changes in agricultural crop acres, M & I use, phreatophyte, reservoir operation and changes in exports to or imports from outside the basin.

(L24) MODEL VERIFICATION

The verification process is the means by which a model's credibility is established through the following steps:

(30) SYNTHESIS ON A COMPUTER

(31) MODEL CALIBRATION

An effort is made to select at least a three year period of record which contains years representing high, low and average water supply conditions. An automatic process has been developed whereby a set of upper and lower parameter bounds are given to the model. It then moves each parameter through the range from the lower to the upper bound. In the process identifying the parameter value which tends to cause the model predicted subbasin outflow to most closely match the actual recorded values. Successive phases of the process are used in an attempt to minimize the effects of parameter interactions.

(32) MODEL TESTING

With the parameter set as determined in the calibration process, data from years other than those used in calibration are fed to the model as a check on its reliability as calibrated.

* * * * * Video Tape * * * * *

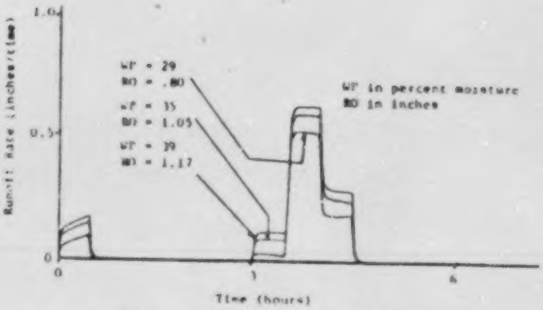
At this point a presentation of a video taped demonstration of the actual Bear River model was made. The physical setting of the Cache Valley subbasin is described and operation of the computer with this data is demonstrated at Utah State University. In the interest of time, only output from the calibration process in digital and plotter form is shown.

* * * * * End of Video Tape * * * * *

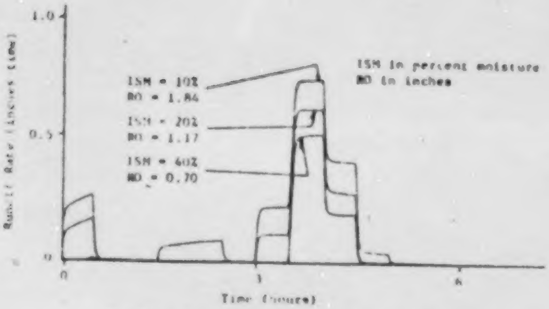
(L25) MODEL RESULTS AND INTERPRETATIONS

(33) SENSITIVITY STUDIES

The response of a model to changing values of one parameter is examined in a sensitivity study. Output from a storm runoff model illustrating this is shown in Figure 14.



Surface runoff as affected by changes of soil wilting point moisture.



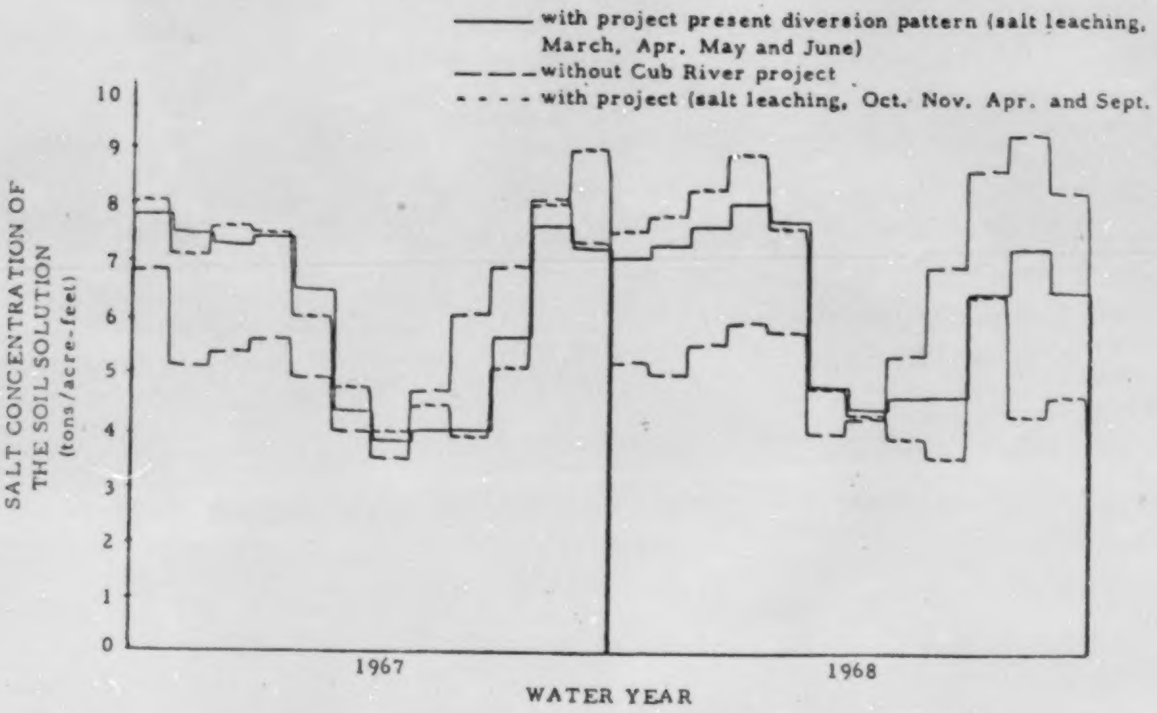
Surface runoff as affected by changes of initial soil moisture.

(34) Figure 14. Typical results from a sensitivity study in which the influences on surface runoff (RO) of changes in system characteristics are demonstrated.

(35) MANAGEMENT STUDIES

One of the main reasons for developing a simulation model is to produce a tool which allows reliable evaluation of the effects of alternative management decisions on a river basin system. The computer model lends itself readily to this role.

Figure 15 serves as an illustration of the models capability to predict the effects of changing irrigation water application patterns on the salt concentration of the soil solution in Cache Valley, Utah.



PREDICTED SALT CONCENTRATION OF THE SOIL SOLUTION

(36) Figure 15. Predicted salt concentrations of the soil solution.

There are many more types of management studies than this. Other common studies are concerned with evaluating the effects on streamflow from proposed changes in reservoir operation and in irrigated land acreages. Other management output is presented by Hill, et. al. (1973).

SUMMARY

It appears to me that the value of simulation models in the context of the Principles and Standards will come through the following:

1. Examination of alternative management effects on the water resource system.
2. Integration of water quality, water quantity and land use planning.
3. More quality for less money with reliable results in generating the effects of alternate plans.

I would suggest the use of a fairly general model as a theme with variations on this theme where needed to fit any particular local requirements in the physical system. If the effects of planning decisions can be determined in the physical sense then politicians, biologists and others can evaluate these effects in terms of their own interests, thus contributing to the total planning effort.

BIBLIOGRAPHY

Hill, R.W., H.L. Huber, E.K. Israelson, and J.P. Riley, 1972. *A Self-Verifying Hybrid Computer Model of River Basin Hydrology*. Paper No. 72084, Water Resources Bulletin. AWRA. Vol. 8, No. 5, October.

Hill, R.W., E.K. Israelson, A.L. Huber, and J.P. Riley. 1970. *A Hydrologic Model of the Bear River Basin*. Report No. PRWG 72-1, Utah Water Research Laboratory, Utah State University, Logan, Utah.

Hill, Robert W., Eugene K. Israelson, and J. Paul Riley. 1973. *Computer Simulation of the Hydrologic and Salinity Flow Systems Within the Bear River Basin*. PRWG 104-1, Utah Water Research Laboratory, Utah State University, Logan, Utah.

Hill, R.W. and J.P. Riley. 1973. *Interactive Hybrid Computer Simulation for Teaching Hydrology and Water Resource Management*. Transaction COED division of ASEE. Vol. V, No. 9, September.

Riley, J.P. 1970. Computer Simulation of Water Resources Systems. *Systems Analysis of Hydrologic Problems*. Proceedings 2nd ISHP. Utah State University, Logan, Utah.

1974. *Planning for Water Quality in the Bear River System in the State of Utah*. PRWG 142-1, Utah Water Research Laboratory, Utah State University, Logan, Utah.

ANALYSIS OF TRADEOFFS

John E. Keith
Utah Water Research Laboratory, Department of Economics,
Utah State University, Logan, Utah

The following discussion is based upon both the economic theory of trade-offs and a methodological approach to measuring those trade-offs developed by Y.Y. Haimes and W.A. Hall (1974). The methodology has the rather elegant name of the Surragate Worth Trade-Off Method. It is based on the principles of mathematical programming.

Theory

Initially, a brief review of the basic theory of trade-offs will be made.1/ Given a set of limited resources, alternative goods and services may be produced, but at some point resources transferred to production of one good will cause a diminution of production of other goods and services. Graphically, the area in which relevant trade-offs occur falls between points X and Y2/. To the left of point X and below point Y, increases in output of either good can be accomplished while increasing output of the alternative good or service. Between the points, increases in one output occur only at the cost of a loss in the other. This is the rational decision space. Note that at any point between X and Y we can describe the cost of increasing production of B as the loss in output of A per unit increase in B $(\frac{\Delta A}{-\Delta B})$. Further, as we devote more resources to producing A the greater is the forfeiture of output of B required. We could put this relationship in a second graph, as in Figure 2, relating the loss in output of B per unit of A produced as we produce more and more A (or less and less B). This $(\frac{\Delta A}{-\Delta B})$ is a kind of price which

---

1/ See Little (1957) or Furgeson (1972) for a more rigorous economic discussion of trade-offs and welfare theory.

2/ See Figure 1.

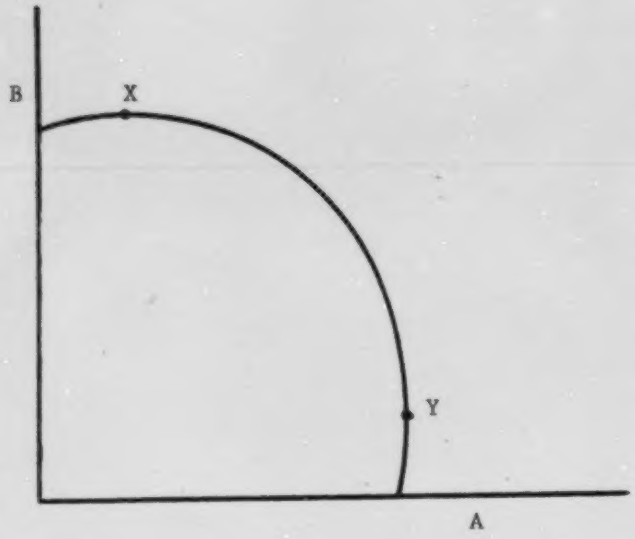


Figure 1 Theoretical Trade-Off Curve

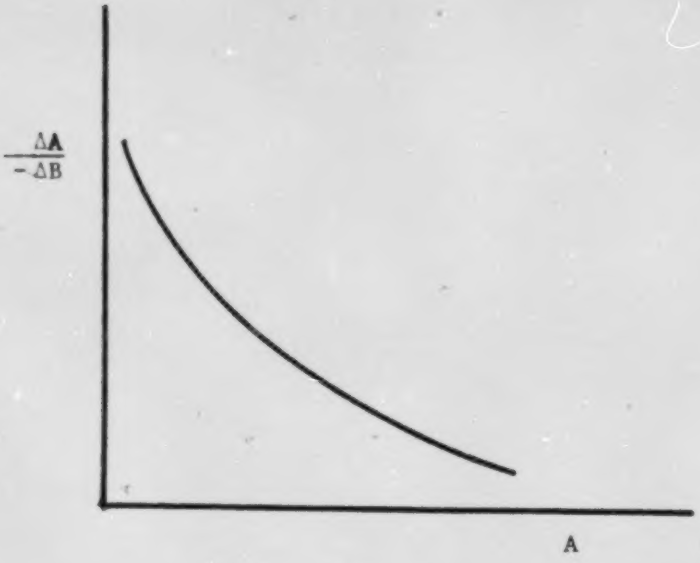


Figure 2 Shadow Price Relationship

indicates what the cost of producing one output is in terms of other output which must be given up. The economic term (or jargon perhaps) for this cost is "shadow price." (A second term which is also used in this context is the "opportunity cost.") Note that at any point along this curve, there is an endowment of A and B on the related trade-off curve. For example, if there is a given output of A, say A*, considered, then we can obtain B* output of B, as in Figure 3.

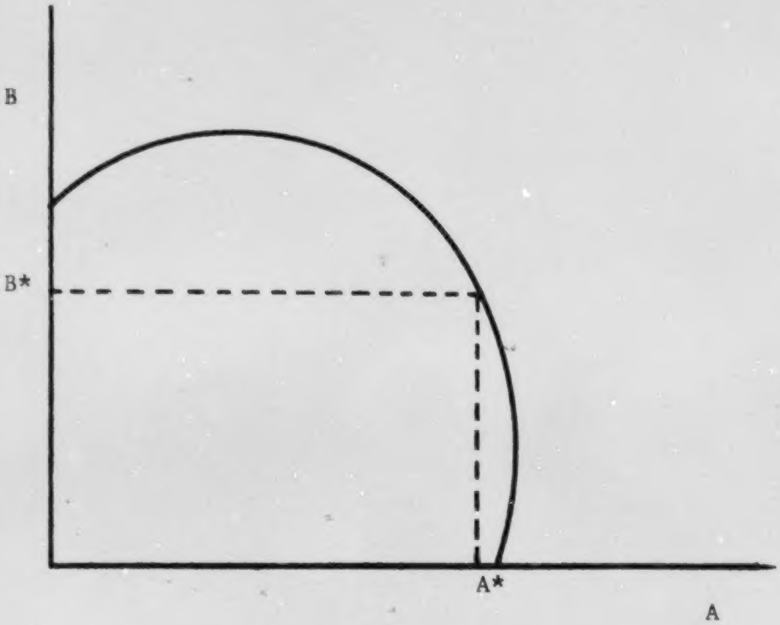


Figure 3 Endowment of A and B

For a unit change in A, we can determine the increase or decrease in B, or the shadow price, which will be commensurate $(\frac{\Delta A^*}{-\Delta B})$. Note as we produce more A, $\frac{\Delta A}{-\Delta B}$ falls, or the amount of B we must give up to get increases in A becomes larger. See Figure 4.

Application to Principles and Standards

There are, of course, obvious applications of these trade-off curves in applying the principles and standards. For example, if we let one "good" be National Economic Development and the other "good" be

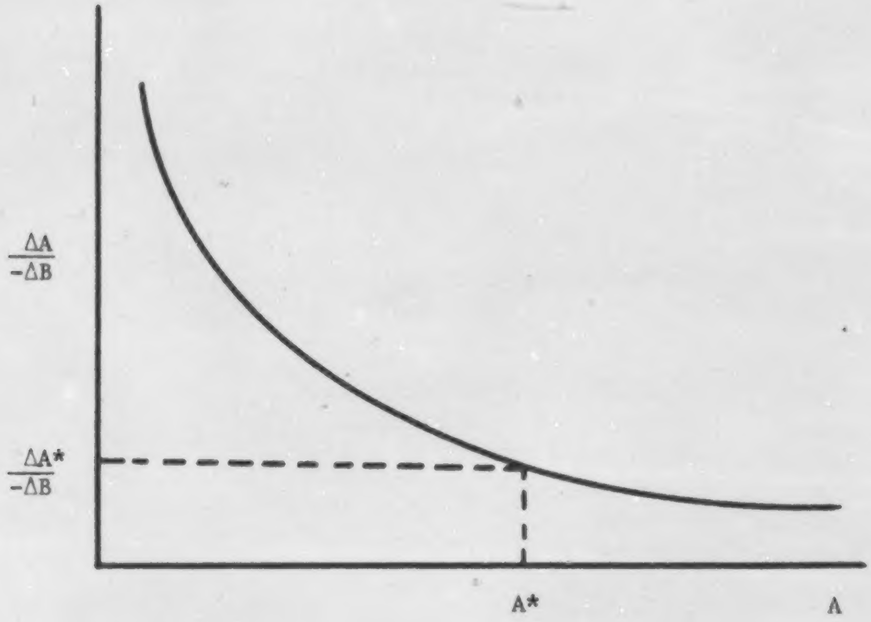


Figure 4 Commensurate Shadow Price

Environmental Quality, then we get the trade-off curves which have been illustrated earlier in the week in several presentations.

According to Figure 5, we must at some point begin to forego environmental quality in order to attain more development. The rationale for this trade-off has been often discussed. A second curve may be further illustrative. Figure 6 shows a trade-off between National Economic Development and Regional Development. The rationale here is that over some range, investments in regional projects will yield discounted returns greater than the investments cost (i.e., benefit/cost (B/C) ratio is greater than one). But beyond some point, say X again, regional development can only take place with a B/C ratio less than one. Obviously, we are giving up national economic development (economically efficient growth) in order to gain improvements in regional development. Clearly, these trade-off curves can be constructed between each of the four accounts, (National Economic Development, Environmental Quality, Regional Development and Social Well-Being) and a rationalization provided for each trade-off curve, at least on a theoretical basis. Thus, the application of this kind of analysis is useful in implementing the principles and

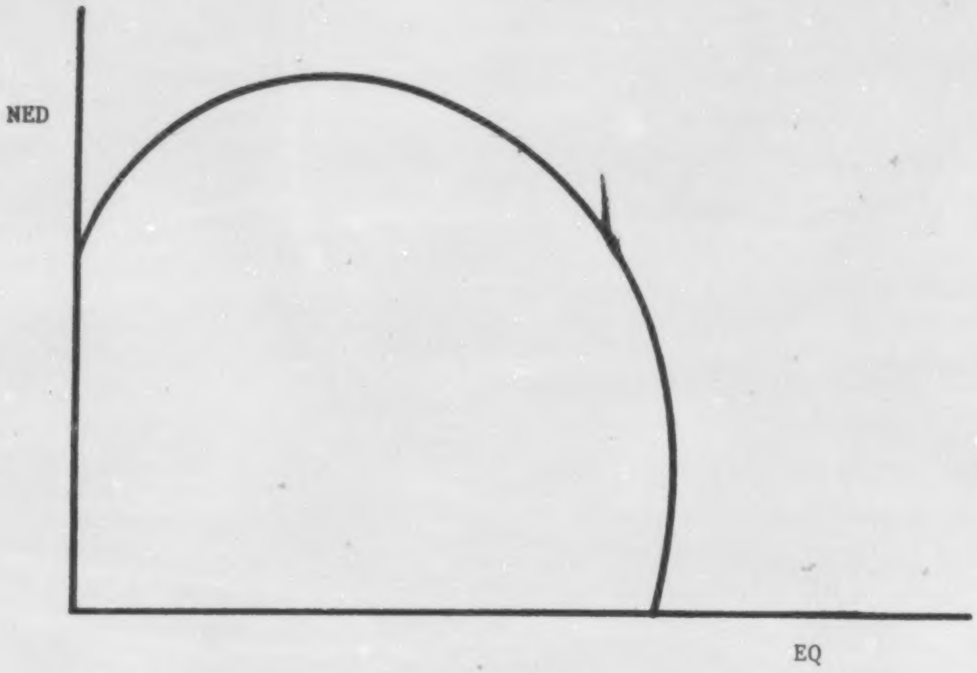


Figure 5 Theoretical Trade-Off Between NED and EQ

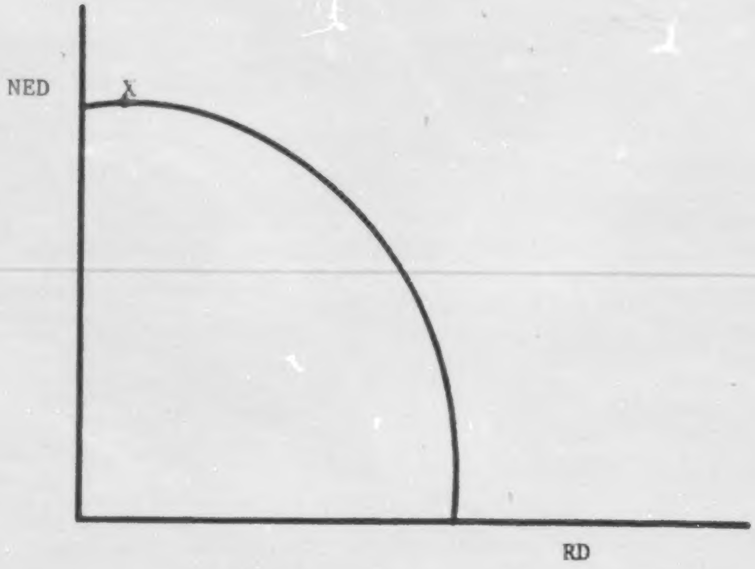


Figure 6 Theoretical Trade-Off Between NED and RD

standards. The development of alternative plans, as part of the Council on Water Resources suggested approach, need not be confined to a few points along the trade-off curves, but instead can encompass the entire range of trade-offs using incremental changes in one or the other of the several goals.

Systems Analysis and Trade-Offs

One problem of major proportion remains even on a theoretical basis. If the trade-offs between categories labeled NED, EQ, RD and SWB are to be considered (or just NED and EQ) indices for each category must be developed. These indices may be relatively simple and widely accepted (as the B/C ratio for NED), but many of the variables may not be easily indexed (the many varied measures of water quality, for example, may not be compatible with a single index).

Systems analysis is a tool which is appropriate for these kinds of large-scale multi-variate problems. At least two kinds of systems approaches are possible: simulation and optimization techniques. Simulation techniques utilize mathematical formulations of relationships between variables. For given changes in one or more variables, changes which occur throughout the system can be observed. Optimization is similar in that a system of related mathematical equations is developed. However, the optimization technique is based upon maximizing (or minimizing) one relationship (or objective) subject to the constraints imposed by the remaining relationships. Further, optimization methodologies which have been developed, principally mathematical programming, yield the increased (decreased) amount of the objective which could be attained if given constraints were relaxed by one unit. These values are equivalent to the shadow prices referred to earlier.

The difference between simulation and optimization is that all of the solution values are simultaneously determined by a specified set of equations in the former while the latter technique will maximize or minimize a given variable and/or equation given the input of the remaining variables and equations. Further, each equation or variable can be designated as the "objective function" in turn, yielding optimal values for that equation subject to the constraints. By utilizing the techniques of mathematical programming, changes in optimum values of the objective function or variables which result from changes in constraining variables can be determined. This is known as parameterization. Thus, the optimization technique (or the simulation technique with more effort and computer calculations) can yield a set of trade-off curves for varying levels of constraints and objective functions.2/

These trade-offs are expressed in physical units or indices of one kind or another. A series of trade-offs between several objectives can be produced by changing the objective functions, so that each objective is maximized or minimized subject to constraints from other objectives, as well as other constraints.3/ For example, NED may be maximized subject to EQ, RD, and SWB. Then EQ may be maximized subject to RD, SWB and NED and so forth for each objective. These trade-offs can be used to analyze the range of trade-offs from which alternative plans may be developed. These trade-offs curves are not necessarily plan specific, but can be used to generate alternative plans within the rational decision space.

Trade-Off Requirements

The systems analysis methodologies, both simulation and optimization, require that the functional relationships be interdependent. Otherwise, changes in a given variable or constraint will not result in changes in other variables in the objective function. Therefore, logical linkages between constraints and objective functions must be established. These linkages include or are related to the indices for each objective and constraint, if indices are utilized, so that changes in one variable may yield both changes in the index for that constraint as well as the index for the objective function. Without the logical linkages, trade-offs and changes will not be related in a usable way.

2/ Note also that the optimization model will immediately identify the "maximum plans" which are required by principles and standards when the other constraints or objectives are not binding on (that is, they do not restrict) the objective functions. If areas of complementarity exist, they will be taken into account automatically by optimizing techniques.

3/ A rigorous mathematical derivation of this process is included in the accompanying appendix, simplified from the Haimes and Hall derivation.

There also exist several mathematical requirements which must be met in order to utilize mathematical programming techniques to generate trade-offs. These requirements are discussed at length in any text on linear or mathematical programming (Hadley, 1962, for example). These requirements are essentially logical consistency, which is also a necessity for simulation models. Development of both simulation and optimization models which will generate trade-offs is obviously a rather complicated task, but it appears to be the least difficult way of meeting the full requirements of the Principles and Standards.

Virgin River Example

As an example, the following trade-off curves were developed from a linear programming problem 4/:

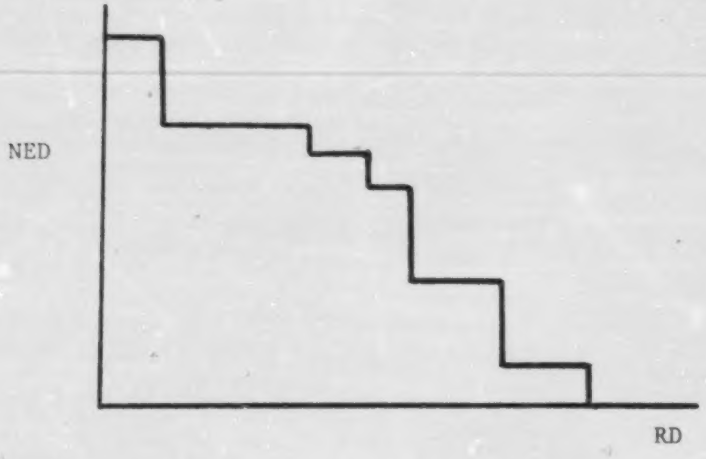


Figure 7 NED-RD Trade-Off for the Virgin River Basin, Utah

4/ These curves were derived from a mathematical programming model of agricultural water allocations in the Virgin River Basin in Utah. The objective function was net returns per acre, and constraints included available water, water requirements for crops, costs of water and crop production and municipal and industrial requirements (fixed demands). Model description can be found in Keith, et al., (1973).

This curve can also be translated into the shadow price formulation, as in Figure 8.

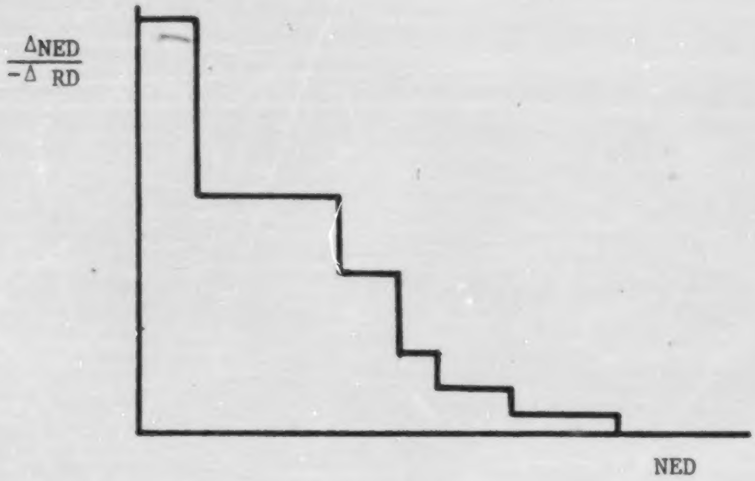


Figure 8 Shadow Price Relationship for NED-RD in the Virgin River Basin

First, some explanations of the curve itself are required. The "stepped" function is typical of linear programming output, since constraints and objective functions are most often expressed in linear forms (non-linear programming can be exceedingly costly and difficult in larger models) Thus, solutions are discontinuous at specific points where a constraint which previously had not been binding becomes a limiting factor, or where the constraint system makes a "quantum jump" in its effect on the objective function. A continuous curve can be fitted statistically to these points, or to the mid-points of each horizontal segment to obtain a continuous curve similar to those in the theoretical discussions, although a continuous curve is not a necessity for a trade-off analysis.

In addition, the indices of NED and RD were determined to be economically efficient agrcultural production and municipal and industrial (M&I) requirements. Economically efficient production does, of course, satisfy the National Economic Development criteria (that is, development produces sufficient output to pay off the investment). Increasing M&I demand is a proxy for regional growth only if the following assumptions are made:

First, increasing M&I requirements are a result of economic development in the region, and that such development does not alter the technology nor profitability of agricultural production. Second, M&I requirements will be met before agricultural water is used. Finally, M&I requirements increase in proportion to regional development (i.e., they serve as a proxy for an index of growth). Assumptions similar to these were also made in order to generate an NED-EQ trade-off curve. Figure 9 is this curve.

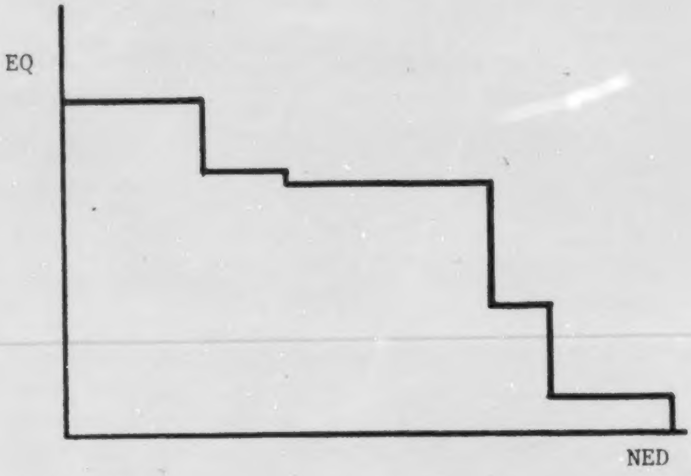


Figure 9 NED-EQ Trade-Off for the Virgin River Basin

Figure 10 is the shadow price trade-offs. These trade-off curves were based upon the assumption that agricultural producers would be required to meet minimum water quality standards, and would be required to assume costs of treatment up to and including secondary treatment costs similar to those of municipal and industrial treatment. This cost is a proxy for environmental quality if those treatment costs are proportional to increased water quality.

It is possible in interface optimization and simulation models in order to more directly evaluate the effects of various constraints on the objectives. For example, a water quality simulation model which uses inputs from an optimization model can be adapted to input water quality data to that optimization model in an interactive process, so that specific water

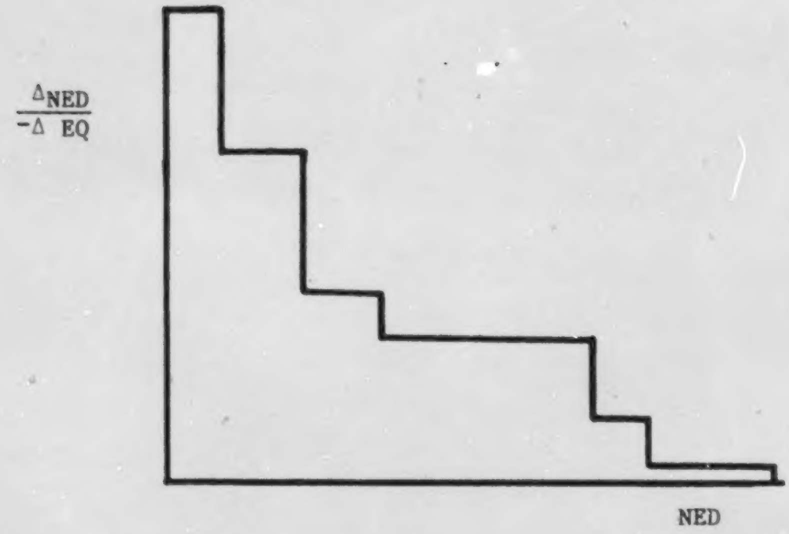


Figure 10 Shadow Price Relationship for NED-EQ in the Virgin River Basin

quality (EQ)-production (NED) trade-offs can be determined. Further modification and detailing can make both models more capable of producing specific trade-offs. Of course, the more specific and precise the modeling requirements, the more detailed are the data needs and the more expensive is the effort required in both time and money.

Some Qualifications on the Use of Systems Analysis

The trade-off curves illustrated must be viewed in the context of giving the physical trade-offs between two objectives, given that all other objectives and constraints remain constant. For example, the NED-EQ curve illustrated applies only to a specific set of RD and SWB assumptions. For any other set of RD and SWB constraints in the model, a different NED-EQ curve would be generated. Thus, each of these curves is a member of an (infinitely) large family of trade-off curves. Even though RD and SWB are accounts, not objectives, of the Principles and Standards, the assumption of various specific constraints associated with these accounts (for example, alternative projected regional developments) within the model will yield a family of NED-EQ trade-off curves consisting of one curve for each level assumed for a constraint (alternative development).

The development of alternative plans, as required by the Principles and Standards, can be confined to a specific area of the rational decision space and from there serve as the specific assumptions, so that a family of trade-off curves representative of alternative plans can be developed with respect to all the other constraints and objectives. As a specific example, Figure 9 represents the trade-off between NED and EQ, given the level of regional development which the State of Utah has projected for a specific year (from a modification of the OBERS projections for Utah). For any other year, the level of development (specifically M&I requirements) will differ. Given more development, water available for agriculturalists will be diminished, and the zero-water-treatment cost (i.e., no quality consideration) rate of output will be less than the intercept indicated in Figure 9, and the trade-off curve will be altered in slope as well. If little growth is expected over the period of time under consideration for a given plan, then the problem is minimized. If, on the other hand, much expansion is expected, or if there is considerable doubt about how much growth is to be expected, the development of a single trade-off curve as representative is questionable.

There also exists a further caution with regard to the use of systems analysis to develop trade-offs. The coefficients of the mathematical equations are most often fixed in the models, but they are derived from stochastic data so that each coefficient is accurate only within some upper and lower bound. There are techniques available in optimization methodologies to test how much effect changes in a given coefficient will have, so that variables which are critical can be examined more closely for accuracy. (These are termed "ranging techniques"). Thus, the trade-off curves are more nearly trade-off bands which include the coefficient variability.

Selecting Alternative Plans

Once the physical trade-offs have been constructed for various alternative assumptions, they can be utilized to determine the appropriateness of specific plans with respect to the wishes of the society. In theoretical terms, once we have the production frontier and the trade-off curve for output, we need to have a measure of the relative value of each output to determine the correct mix. Economists call this measure a price line when the production of market goods is involved, or an indifference curve when public values are involved. Figure 11 is an example of an indifference curve-production trade-off analysis, where I is the public or social indifference curve. The tangency of the trade-off function and the indifference curve I_1 is the "optimal" trade-off. Any other combination of outputs (say at point Z) will yield less satisfaction (I_o) to the public. A major problem in all of planning is how to determine the public indifference curve, so that an optimal plan, one which yields the greatest public satisfaction, can be determined. There have been some methodologies suggested, dealing primarily with political feasibility.5/ These analyses implicitly use political acceptability and feasibility as proxies for public satisfaction, and assume two precepts: first, that politically feasible policies of plans are more productive of public satisfaction than those policies or plans which are not feasible; and second, that political decision-makers, primarily but not exclusively elected officials, are capable of determining political feasibility.

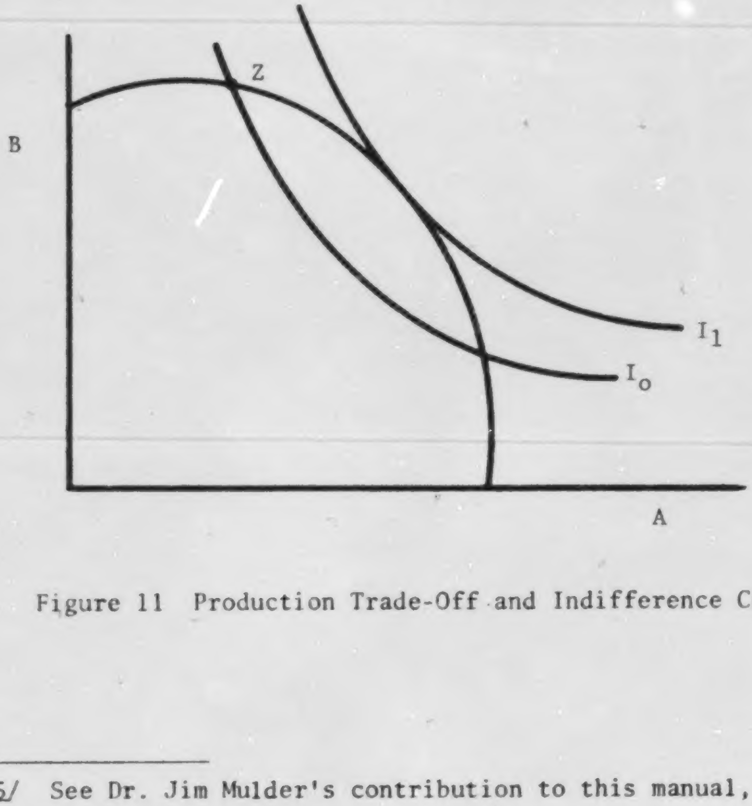


Figure 11 Production Trade-Off and Indifference Curves

5/ See Dr. Jim Mulder's contribution to this manual, for example.

The public participation part of the Principles and Standards is in this way taken into account. However, there is no reason that individuals and groups within society could not participate in these methodologies, and other approaches do include such participation.

A Suggested Methodology

The approach suggested by Haimes and Hall begins by generating the physical trade-offs which are attained using optimization techniques as discussed earlier. Political decision-makers (both elected and non-elected, assumably) are interviewed in order to obtain their estimation of political feasibility. Each decision-maker interviewed is given an initial endowment of objectives (so much efficient development and water quality of a given level), then he is asked to relate whether he would be willing to trade, in a political sense, the amount of one objective for the amount of the other objective, determined by the physical trade-offs. If he is, the endowment is changed to correspond to the trade-off, and the next trade-off is presented and so on until the decision-maker indicates that he is indifferent to some trade-off. This procedure would then be repeated starting from an endowment maximizing the second objective. Thus the "indifference band," or the ranges of endowments and trade-offs to which the decision-maker is indifferent, is determined. Figure 12 illustrates such an indifference band, I, for a given trade-off curve. Note that both the endowments and the trade-offs are presented, in contrast to other methodologies. If every involved decision-maker has an indifference band which includes a given segment of the trade-off curve, then the politically viable plan or alternative will be the plan which yields that segment of endowment and trade-off. That is, no decision-maker will object to that combination of output, and therefore, the public satisfaction will be maximized (given the assumptions of "representativeness"). If, on the other hand, there exists no segment over which all decision-makers agree (normally the case), then political viability will have to be determined by the power position of each decision-maker (and his constituency) or by shifting other constraints until a trade-off curve on which all decision-makers' indifference bands overlap is achieved.

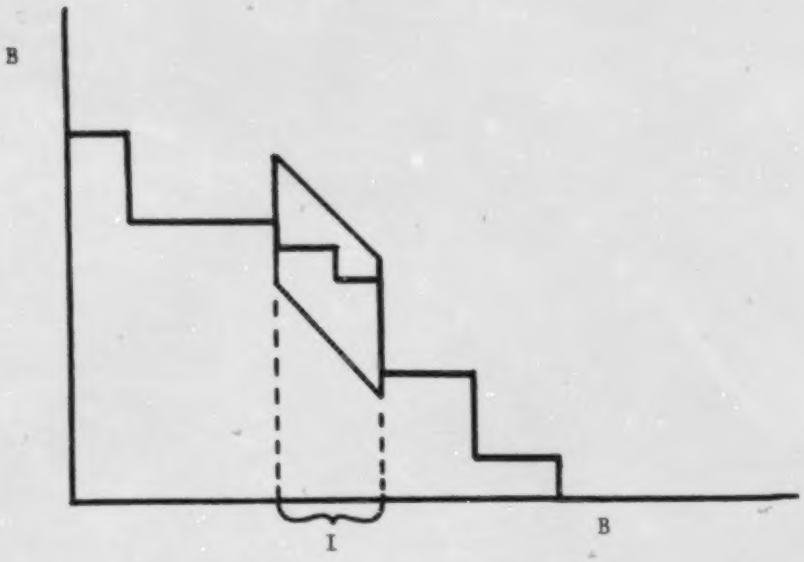


Figure 12 Indifference Band

There are, of course, problems with such a methodology, including the ability of decision-makers, particularly non-elected ones, to estimate or reflect constituent attitudes, the appropriateness of political viability as a measure of public satisfaction, and the problems associated with changing public opinion, interest, and action. No methodology which attempts to measure social values is entirely free of these kinds of objections. The suggested methodology does proceed from, and include explicitly, the physical possibilities and trade-offs as specified conditions. The practical question is whether or not this methodology satisfies the Principles and Standards requirements for public participation, and whether it meets the test of actual use.

In summary, the systems analysis approach to implementing the requirements of the Principles and Standards has some difficulties. However, the impossibility of understanding and manipulating the tremendous number of variables and complex relationships which must be considered by individuals in policy-making positions necessitates the use of systems analysis in order that a reasonably clear view of outcomes be generated. The generation of trade-offs and endowments, in physical terms, adds significantly to the information available to decision-makers. The explicit examination of choices and reasons for preferring a specific set of outcomes or policies appears to be a major benefit to the decision-making process, and a step toward the implementation of the Principles and Standards.

Bibliography

Ferguson, Charles E., 1972, Microeconomic Theory, 3rd ed., R.D. Irwin, Homewood, Illinois.

Hadley, G., 1962, Linear Programming, Addison-Wesley Publishing Company, Reading, Massachusetts.

Haimes, Y.Y., and W.A. Hall, "Multiobjectives in Water Resource Systems Analysis: The Surrogate Worth Trade-Off Method," Water Resources Research, August, 1974, pp. 379-388.

Keith, John E., Jay C. Andersen, and Calvin G. Clyde, 1973, The Economic Efficiency of Inter-Basin Agricultural Water Transfers in Utah; A Mathematical Approach. PRWG100-3, Utah Water Research Laboratory, Utah State University, Logan, Utah.

Little, I.M.D., 1957, A Critique of Welfare Economics, 2nd ed., Clarendon Press, Oxford, England.

Appendix

Assume two objectives, f_1 and f_2, which are functions of one variable, X. Suppose both ovjectives are to be maximized. A maximum value for f_2, called $\overline{f}_2$, can be found.

$$\overline{f}_2 = Z_o \text{ where } Z^o \text{ is a scalar.}$$

This equation can be rewritten as a constraint:

$$f_2 \leq f_2 = Z_o$$

$$\text{or} \quad f_2 \leq Z_o \tag{1}$$

Manipulating further

$$f_2 = Z_o - \delta^2 \text{ (where the squared term assures positiveness)} \tag{2}$$

also call

$$(Z_o - \delta^2) = \varepsilon_2$$

Forming the Legrangian expression

$$L = f_1 - \lambda(f_2 - Z_o + \delta^2) \tag{3}$$

and taking the partial derivatives to determine a maximum:

$$\frac{\partial L}{\partial X} = \frac{\partial f_1}{\partial X} + \frac{\partial f_2}{\partial X} \tag{4}$$

$$\frac{\partial L}{\partial \lambda} = f_2 - Z_o + \delta^2 \tag{5}$$

$$\frac{\partial L}{\partial \varepsilon_2} = -\lambda \qquad (6)$$

$$\frac{\partial L}{\partial \delta} = -2\lambda\delta \qquad (7)$$

Solving (4) for a maximum

$$f_1' + \lambda(f_2') = 0$$

$$-\lambda = \frac{\partial f_1}{\partial X} \qquad \frac{\partial f_2}{\partial X} = \frac{\partial f_1}{\partial f_2}$$

[The same result can be obtained by noting that at optimum in equation (6)

$$L = f_1 \text{ , and } \varepsilon_2 = f_2 \text{ , so that } -\lambda = \frac{f_1}{f_2} \text{]}$$

Thus, (the Legrangian multiplier) equals the shadow price, $\frac{\Delta f_1}{\Delta f_2}$.

For example, assume

$$f_1 = 25 - (X-4)^2$$

$$f_2 = 15 - (X-10)^2$$

$$\overline{f}_2 = 15$$

$$f_2 \leq 15 - \delta^2$$

Pick $\delta = 20$ or $f_2 = -5$

$$L = 25 - (X-4)^2 - \lambda[20 - (X-10)^2]$$

$$\frac{\partial L}{\partial X} = 2(X-4) - 2(X-10)$$

$$\frac{\partial L}{\partial X} = 20 - (X-10)^2$$

Solving

$$-(X-10)^2 = -20$$

$$X - 10 = \pm\sqrt{20}$$

$$X = 10 \pm \sqrt{5} = 5.53 \text{ or } 14.47$$

For $X = 14.47$, $2(14.47 - 4) - 2\lambda(14.47 - 10) = 0$

$$\lambda = \frac{-14.47}{-4.47} > 0$$

For $X = 5.53$, $2(5.53 - 4) - 2\lambda(5.53 - 10) = 0$

$$\lambda = \frac{-1.53}{4.47} = -.34$$

or one unit of f_2 given up yields only .34 units of f_1 increased. In sum,

$$f_1 = 22.66$$

$$f_2 = -5$$

$$\lambda = -.34$$

For $\delta^2 = 5$ or $f_2 = 10$

$X = 7.765$

$f_1 = 10.82$

$f_2 = 10$

$\lambda = -1.68$

or one unit of f_2 given up yield 1.68 increase in f_1.

Increments of δ^2 can be included so as to describe the entire trade-off curve, as in Figure A-1.

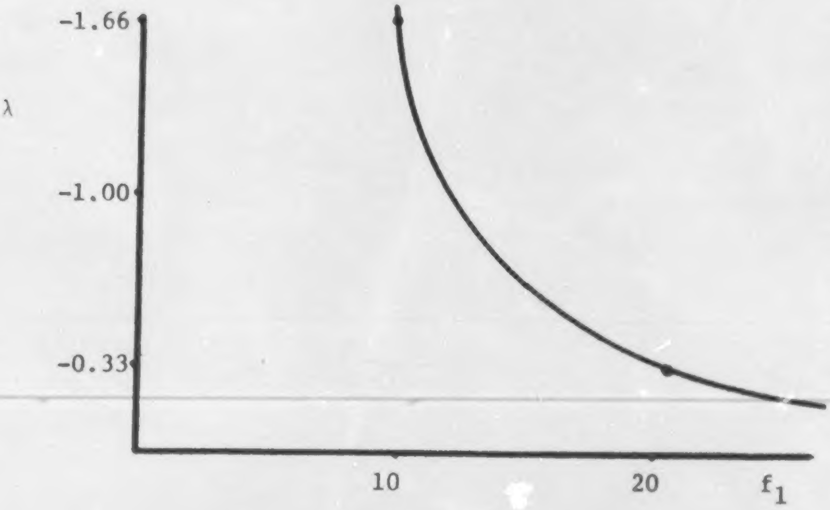


Figure A-1 Example Trade-Off Curve

DETERMINATION OF POLITICAL FEASIBILITY*

Jim Mulder
Department of Political Science, Utah State University
Logan, Utah

The aim of this paper is to show how a systems approach can be used to analyze the effects of social and political factors on the feasibility of alternative plans. Specifically, it will be demonstrated how a computational procedure can be employed that can be helpful in determining the political feasibility of a plan that is defined in terms of a systems framework incorporated in PROPDEMM, a programmed policy decision making model.[1]

Traditional Historic Planning Approach

The paper will begin with a consideration of the traditional planning approach that is characterized by an emphasis on the estimation of physical and economic trade-offs as distinct from an approach that includes the systematic analysis of social and political variables. It will be argued that the Principles and Standards imply an evaluative framework that necessitates a structured concern with social values and political realities, which can only be accomplished through the application of modeling and simulation techniques. The benefits that can be obtained from the use of such techniques will be briefly summarized. Then the conceptual and theoretical structure that underlie the PROPDEMM simulation will be outlined, followed by a description of its basic components. Next, the computational procedure will be described that is used in PROPDEMM to determine the political feasibility of a course of action. The discussion will conclude with some suggestions concerning the use of social-political models in implementing the Principles and Standards.

---

*Subtitle: Systems Modeling of Social-Political Interactions: An Application Relevant to the Principles and Standards for Planning Water and Related Land Resources. Some of the material in this paper is taken from the author's Ph.D. dissertation, "The Development and Application of PROPDEMM; A Computer Simulation of the Policy Process in Water Resources Planning. Syracuse University, 1974.

[1] Although the terms POLICY and PLANNING are not the same, they are closely related in that the decision processes are virtually identical, at least from a normative point of view. These terms will therefore be used synonymously in this discussion, it being understood that the focus of reference is with respect to the decision making process.

Historically, water resources planning has been primarily carried out by engineers and economists.[2] Only few sociologists and political scientist have in the past participated in planning or research in the water resources area. This lack of participation by social scientists has to a significant extent been due to the heavy emphasis placed in traditional water planning on construction projects and the calculation of economic costs and benefits. Social and political factors, if taken into account at all, were evaluated in intuitive and "common sense" terms. Ironically, social scientists were rarely consulted, in part because they employed "subjective" or "intuitive" investigative techniques, which were, and are, antithetical to the biases of engineers and economists.

Multiobjective and Comprehensive Planning

During the last 10-15 years a number of interrelated developments took place that have significantly altered the more recent approaches to planning.

1. American society has become significantly more complex in terms of the number and types of interactions in the system.
2. Changes are occurring at a faster and increasing rate.
3. Social and political consciousness among decision makers and the public is more evident.
4. Methodologically more emphasis has been placed on the analysis of total systems that takes into account the interactions and interrelationships among the major variables affecting a problem area.

---

[2] For a more detailed discussion of the historical development of water planning, see a study by Hoggan, Mulder, and their associates on the effectiveness of water planning efforts (1974).

5. Social scientists have developed more expertise in working with mathematical and quantitative techniques and are thereby better able to bring their knowledge to bear on complex planning problems.

The increased complexity of society and the faster rates of change have made prediction much more difficult, especially in relation to social issues, and consequently a premium is placed on planning. In the contemporary setting it has become imperative that planning be undertaken in a way which allows for the integration of all available information. The emphasis placed on multipurpose, comprehensive planning is a step in the right direction, but so far this emphasis has been more theoretical than applied. In part this has been the case because of a lack of knowledge about the organizational forms and procedures that could be used to implement multiobjective planning. Moreover, there has been no methodological framework that can readily combine physical-environmental and social-political factors. The U.S. Water Resources Council's Principles and Standards are a significant effort aimed at developing the organizational and procedural prerequisites for comprehensive planning. In addition, several interdisciplinary teams across the country have been working on the development of appropriate systems approaches, PROPDEMM being one such approach.

The basic problem that must now be addressed by water planners concerns the integration of economic and hydrologic models with social science approaches. The Surrogate Worth Trade-Off method, for example, represents an approach that is especially suitable for obtaining inputs from decision makers and the public about economic and physical trade-off preferences. The information developed from the use of this method, when combined with data about social and political interactions, is very useful in a comprehensive planning effort, as envisaged in the Principles and Standards. However, the integration of the various types of information can perhaps best be accomplished through the use of broader simulation techniques, particularly if social-political information is to be included. Specifically, the type of simulation/modeling that can fit the integrative planning needs well is one that incorporates a policy analysis framework. The utility of such modeling is considered in the next section.

The Utility of Policy Modeling and Simulation

It is important to recognize that such techniques as the Surrogate Worth Trade-Off method should be placed within a perspective that includes the total system, incorporating physical, economic, and social issues, as advocated in the Principles and Standards. Sophisticated models that describe physical and economic relationships have been developed and are available. Unfortunately, there are only few social and political models that are operational and can be used by policy makers and planners. That there is an important and urgent need for such models has been recognized by a number of writers, who have generally based their comments on the following types of arguments:

1. The complexity of policy/planning problems necessitates the use of the more recently developed techniques of management analysis in dealing with social problems.
2. Methods and models should be developed that can help to deepen the understanding of policy makers in confronting a complex range of problems to aid in the invention of better policy solutions.[3]
3. The formal analysis that is inherent in modeling improves the formulation of policy in that it helps to provide a rationale and methodological procedure for arriving at a policy choice, forces a detailed analysis of the problem area, and illuminates controversy by identifying basic differences. (Keeney and Raiffa, 1972)
4. A policy model can provide a framework that can aid in the systematic analysis of the interactions among the different elements of a system.[4]

---

[3] In a discussion on the nature of policy formation, Raymond Bauer noted the importance of providing the practitioner with tools that can help him in policy making. This has not been sufficiently achieved in the policy area (Bauer, 1968).

[4] Systems analysts generally have stressed the importance of studying interrelationships among various components of a system. As Lane (1972) points out, this type of analysis is as relevant in policy studies.

5. A framework is necessary that can aid in the systematic analysis of policy consequences in relation to policy aims (Cook and Scioli, 1971).[5]
6. Much knowledge and information that is available to policy makers is not used. An operating model of a policy system can help to insure that relevant information is brought to the attention of the decision maker or policy analyst.[6]

Endorsements similar to those advanced in favor of modeling in general are also applicable to simulation, the type of modeling that has long been used by water resources engineers and economists, but less frequently by political scientists. In fact, the advocacy of the use of simulation techniques in the social sciences has at times been so enthusiastic in the last few years, that some authors have cautioned against their unrestricted application.[7] Simulation should not be used to present ready-made answers to planners or policy makers. The use of simulation models in planning should be guided by instrumental and pragmatic considerations, not by deterministic or idealistic fervor. It is therefore important to be aware of the advantages and disadvantages that obtain from the application of simulation methods in the policy making or planning process.[8] For example, criteria for evaluating an operational simulation model should include:

1. The ease with which large quantities of data can be organized, analyzed and managed.
2. The potential that is present to selectively study different elements and aspects of the referent system.
3. The possibility of testing, modifying and retesting assumptions about the referent system.

---

[5] The point has also been developed by Dror, who considers the gap between policy objectives and outcomes to be the result of an underdeveloped policy science (Dror, 1968).

[6] Dror (1968) makes this point persuasively and notes that various other authors have also observed this.

[7] For example, Dror (1968) warns against several pitfalls of modeling planning or policy processes, as does Hoos (1972).

[8] For some insightful discussions, see Dutton and Starbuck (1971), and Raser (1969).

4. The cost savings that can be accomplished by experimenting with simulated processes before actual implementation.
5. The heuristic value that can be obtained by familiarizing planners, policy makers, and concerned citizens with detailed elements of complex structures and processes.
6. The degree to which the explicit consideration of variables and processes is encouraged.

The simulation model described in this discussion should be viewed as part of a continuing development in moving toward the increasing application of technological capabilities in planning and policy making. Other operating models relevant to planning and policy making have been developed, but their focus and level of abstraction has been such that their application has been limited.[9] No policy/planning models have so far been developed that integrate the major components of a policy/planning effort, enabling decision makers and researchers to investigate detailed elements of large-scale planning situations. PROPDEMM is an additional step in the development of policy/planning simulation modeling, as described in the following sections.

The Policy/Planning System: Theoretical Formulation

Each model or simulation has an underlying structure that is expressed in the conceptual orientation and theoretical language used to describe its operation. A complete description of a simulation must therefore include an explicit statement of the conceptual and theoretical assumptions that form the basis for its design.

To develop a computer simulation that would have a practical value for policy makers it was initially necessary to resolve two conceptually separate, but related problems. First, the meaning of the term "policy" had to be analyzed. The basic elements that make up the policy decision making process had to be identified so that they could be incorporated as components of a programmed model. Second, policy implications had to be explicitly defined. Additional factors needed to be identified that could express the meaning of a policy implication in a structured way and could be related to policy elements. These two problems were resolved by following the procedures described below.

---

[9] Examples of policy/planning simulation models are described by Davis and Hinich (1966), Keeney (1972), and Kane (1973).

The view subscribed to here is that *political decision making* is essentially the process of initiating actions or plans which are to resolve conflicts among different interests, or, in the special case, promote particular interests. *Policy decisions* are political decisions of a certain kind. They are decisions which include a time perspective that is tied to a basic set of explicit or implicit objectives. For example, a decision which involves an immediate, one time allocation of a resource is a political decision but not a policy decision. A decision which specifies how resources are to be allocated over time is a policy decision. Under this interpretation of policy, it is assumed that there are essentially four elements, in addition to the decision making body, which define the nature of a policy decision. That is, if we wish to study how a particular policy or plan comes about, we must identify four types of variables as shown in Figure 1.[10]

Policy Maker Course of Action

Taking the decision maker(s), or policy maker(s), as the central figure(s) through which policies become operative, four types of variables are identified in Figure 1. These four variables form the basic *social-political* elements that explain the eventual choice of a policy, plan or course of action. The four elements are:

1. The various interest groups whose characteristics influence and constrain the policy maker's actions.
2. The values that are held by the interest groups or are perceived to be important by the decision maker.[11]

---

[10] In this discussion the decision maker will be treated as a given. Therefore, the psychological aspects of policy making will not be considered. It will also be assumed that the decision attempt to maximize their own interests. These simplifying assumptions are made because they do not interfere with the analysis of the policy simulation in this study.

[11] Following Kluckhohn (1962), a value is defined as "conception...of the desirable which influences the selection from available modes, means, and ends of action."

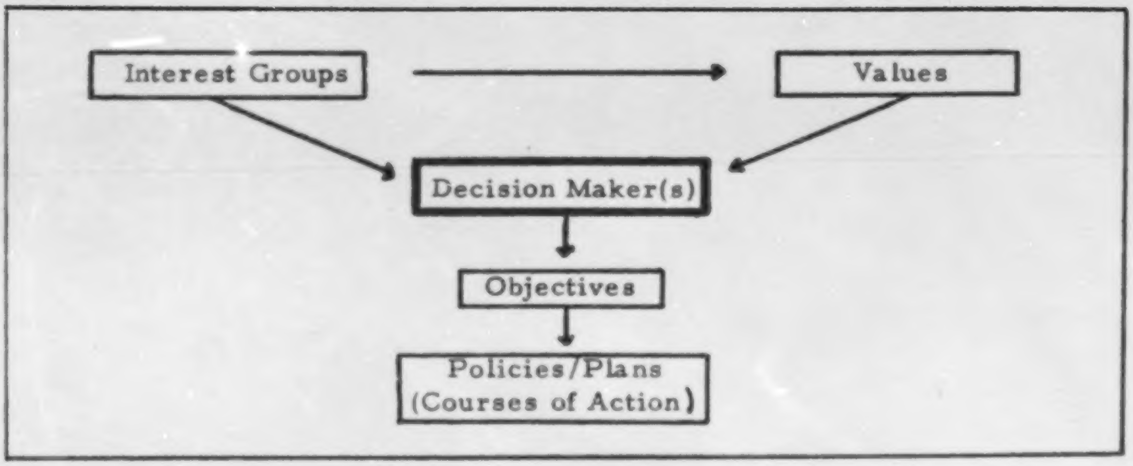


Figure 1 The Elements of a Policy Decision.

3. The objectives that are a result of an analysis of the policy problem and that are defined as representing operational expressions of the values affected by the policy that is to be implemented.
4. Alternative policy plans or courses of action that may be proposed for implementation.

These are the variables that must be included as components of a simulation that is used to develop or study policy decisions.

A useful policy simulation does not only describe the relationships that lead to a particular policy; it should also indicate what the relevant consequences of that policy may be. A policy decision is not implemented in a vacuum; it certainly affects the social system and usually affects the natural environment. The questions involved in determining the implications of their decisions with respect to social and environmental variables present perhaps the most significant and difficult problem for policy makers. For example, when they propose policies which affect the natural environment, policy makers must take into account diverse social interactions as well as complex ecological systems. Considering the complexity of the task it is not surprising therefore that in the past catastrophical consequences have resulted from seemingly benign policies.

Policy Implications

Analytically, the study of policy implications can be resolved into three elements, beginning with an assumption that a particular policy has been selected for consideration (see Figure 2).

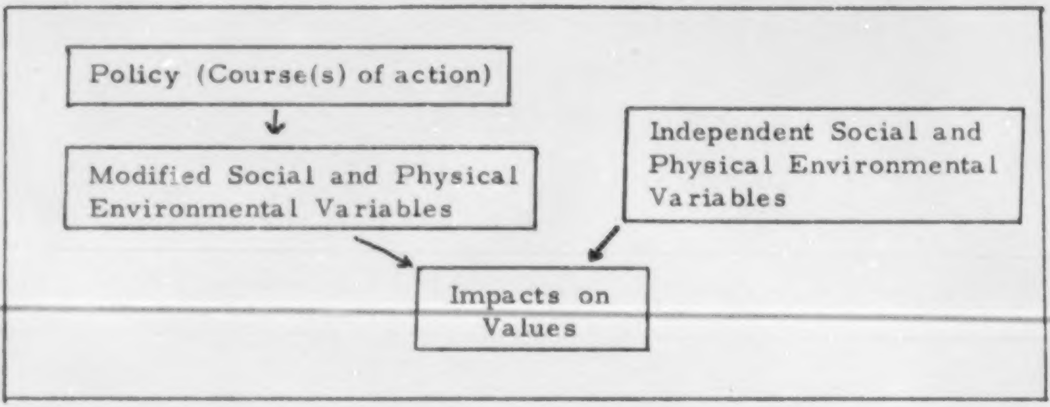

Policy (Course(s) of action)
Modified Social and Physical Environmental Variables
Independent Social and Physical Environmental Variables
Impacts on Values

Figure 2 The Elements of Policy Implications

Figure 2 implies that a policy is designed to bring about (1) modifications in a particular set of social and environmental variables, which combined with (2) a set of nonmodified or independent social and environmental variables cause (3) certain impacts on the values of the different interest groups in the social system. To study the implications of a given policy it is necessary that these three elements be made explicit, again involving the collection and analysis of much information.[12]

There are two arguments presented. One is that the implications of a policy can be evaluated in terms of the modifications of social and environmental variables. The second argument is that in analyzing policy implications our basic interest is to insure that desired impacts, positive or negative, will be effected on the set of values that were determinants of the policy. These impacts are the result not only of the modifications in social and environmental variables that are intended by the policy, but also of independent social and environmental variables that are not under the control of the policy maker(s).

---

[12] Figures 1 and 2, when combined, present a policy model that fits quite well in the policy framework described by Dye (1972).

An example that demonstrates the above arguments might be a policy that is intended to increase recreational opportunity and water supply. The environment is modified through the construction of a dam which results in a lake that can be used for fishing and boating and at the same time is a reservoir that retains water for usage by consumers. Thus positive impacts are effected with respect to the values of recreation and water supply. But one environmental variable that is not under control of the decision makers is the degree of precipitation. If there is little precipitation, the impacts on recreation and water supply could still be negative.

PROPDEMM Simulation

As will be shown in the next section, the elements of a policy decision and its implications will be integrated into the PROPDEMM simulation. The common and basic factor that will make such an integration possible are the value concepts. The analysis here assumes that values are fundamental to policy decisions. They enter into the policy process as motivating factors for social and political groups and are necessary for its completion when policy implications must be evaluated in terms of impacts on the same values.

Although a detailed description of the PROPDEMM simulation will be presented in the next section, it is appropriate here to discuss some of its basic features and objectives, in order to relate these to the theoretical underpinnings which govern PROPDEMM's basic assumptions. By describing the outline of the PROPDEMM simulation at this point, later discussion will be facilitated.

During the past two years, PROPDEMM has been developed to simulate decision processes which involve political and social-ecological interactions. The conceptual organization of PROPDEMM is at a fairly high level of abstraction so that the model is general enough to apply to a number of different policy problems. The program has been organized to help accomplish the following four policy planning objectives:

1. The determination of policy planning outcomes, in terms of value impacts, which are associated with specific courses of action for given states of social-ecological factors.
2. The determination of that course of action which maximizes given values.
3. The determination of the political feasibility of a given course of action.
4. The identification of a political strategy to promote a particular course of action by increasing its political feasibility.

The program enables a decision maker to interact with computer accessed data and receive feedback concerning possible impacts from various decisions. Among the input data is information concerning the value relevant to the decision system, critical social-ecological variables, the impacts of these variables on the specified values, and certain basic political variables as related to the same values.

In using PROPDEMM, a decision maker can indicate what decision principles and conditions apply in the planning or policy situation, from which the computer will calculate consequences in terms of the effects on values held by different interest groups within the system. A policy maker will be able to identify various types of interrelationships among sets of values. The analysis of these interrelationships will provide useful insights into problems of multiple objectives planning, which has been the approach used in the comprehensive Williamette river basin study.

The second objective is indicative of another useful programmed capability. For example, a policy maker may wish to maximize a given set of values held by particular individuals, or alternatively, he may wish to maximize a composite of the values of the entire public. PROPDEMM will enable him to calculate the course of action which is likely to maximize the specified set of values, and to define a policy in relation to given courses of action and social-ecological states. PROPDEMM will also indicate the courses of action which have the highest probability of achieving the above types of objectives and will indicate social-ecological consequences related to a course of action. These calculations are therefore especially helpful in providing feedback information and evaluating alternative policies.

The third and fourth objectives which PROPDEMM can help accomplish deal with two crucial questions generally confronting policy makers. Is a particular course of action politically feasible and what political strategy should be followed to promote it? The PROPDEMM accounting scheme used to calculate the political feasibility of a specified course of action is essentially the same as that used in PRINCE.[13] Political feasibility calculations are especially useful in clarifying the nature of political interactions among interest groups, political participation, and policy responsiveness to public demands. Since the political accounting scheme in PROPDEMM is similar to that of PRINCE, the determination of a suitable political strategy also follows the PRINCE pattern. The definition and analysis of alternative political strategies enables policy makers to investigate the interrelationships between stated objectives and certain political variables.

As can be determined from this discussion, the format of the PROPDEMM simulation is compatible with, and closely follows, the analysis of a policy decision and its implications presented in the first section of this chapter as depicted in Figures 1 and 2. Thus the basic data included in PROPDEMM's definition of a policy planning decision problem are the following.[14]

1. A set of values together with an ordinal utility evaluation of the values for interest groups (Figure 1).
2. A set of acts which define a course of action, each act being a step in a sequence of decisions which form a course of action (Figures 1 and 2).

---

[13] For a detailed description of the PRINCE accounting scheme and the various possibilities for its application see William D. Coplin and Michael K. O'Leary (1971 and 1972).

[14] Another clearly stated formulation of the well defined decision problem can be found in William R. Ferrel (1973) and H. Raiffa and R. Schlaiffer (1961).

3. A set of environmental or social-ecological conditions defined in terms of environmental factors, and in turn defining a possible environmental state (Figure 2).
4. A set of outcomes resulting from a course of action defined in terms of value impacts (Figure 2).
5. A probability assessment of environmental conditions and decision outcomes (implicit in Figure 2).

Figure 3 summarizes the operational flow aspects of the simulation.

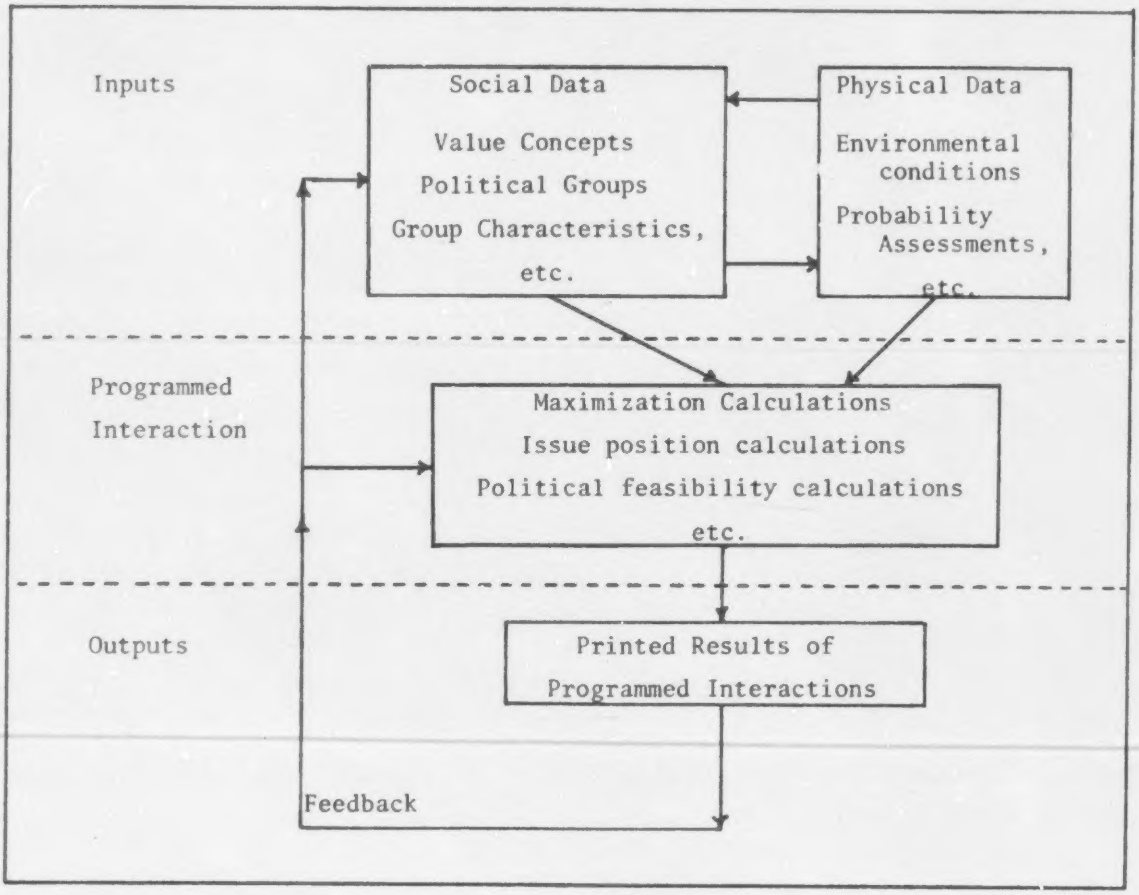


Figure 3

PROPDEMM Structures and Interactions

The fundamental structural elements of the PROPDEMM simulation are three impact matrices, representing the social-political, environmental, and course-of-action components of the planning process. Each matrix consists of a set of number vectors representing desired or expected impacts on a set of defined values. A seven-point scale is used to represent the impact estimates, the meaning of the numbers being approximately as follows:

+3	Strong positive impact
+2	Moderate positive impact
+1	Small positive impact
0	Neutral or no impact
-1	Small negative impact
-2	Moderate negative impact
-3	Strong negative impact

For example, Table I provides important social-political information, showing that businessmen desire only a small positive impact with respect to a clean environment, but want a strong positive impact on economic development and energy availability.

The matrix in Table I is basically a formulation of preferences that corresponds to a more concise mathematical expression that has generally been adopted in decision theory (Edwards, 1967). That is,

$$u_i(x_i) = u(x_1, x_2, x_3, \ldots, x_n) ,$$

when $u_i(x_i)$ represents the objective function of a decision maker, or actor, or group i with respect to a set of values x. The formulation has variously been referred to as a preference function, utility function, or choice function. The use of a group value impact matrix in PROPDEMM is in accordance with the intent of the Principles and Standards, and provides a method for expressing this intent.

> The recommended plan should be formulated so that beneficial and adverse effects toward objectives reflect, to the best of current understanding and knowledge, the priorities and preferences expressed by the public at all levels to be affected by the plan.

Table I Interest Groups and Values

Value Concepts*

Interest Groups	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}
Government Agency	+2	+2	+1	0	+3	+3	+2	+1	+2	+2 [15]
Businessmen	+1	+2	+1	0	+3	+3	+2	0	+1	0
Farmers	+1	+3	-2	0	+2	+2	+1	-1	+2	-1
Environmentalists	+3	0	-1	+2	-1	+1	0	+2	+1	+2
Developers	0	+2	+2	+1	+3	+3	+2	-1	+2	-2

*Key: V_1 - Clean Environment
V_2 - Water Supply
V_3 - Recreation
V_4 - Aesthetics
V_5 - Economic Development
V_6 - Energy Availability
V_7 - Transportation
V_8 - Fish and Wildlife
V_9 - Flood Control
V_{10} - Optimal Land Use

---

[15] The group value vector (GVV).

The group value impact matrix forms the basis for the social-political interactions that can be expected to take place in relation to a plan or set of alternative plans. That is, it is assumed that a policy or plan elicits reactions from interest groups because of the values that are affected. Of course, value commitments are not the only political factors involved in the planning process. Various interactions are influenced or "weighted" by other considerations and group characteristics. PROPDEMM includes formulations that take into account the following social-political factors:

1. Value salience - the importance or significance of a value to an interest group, measured along a seven-point scale.
2. Group power - the influence or ability of a group to obstruct a plan or course of action, measured in terms of a seven-point scale.
3. Group affect - a measure of the affective relationship between two groups, for example, in terms of traditional opposition or cooperation.
4. Group dogmatism - a measure of a group's adherence to its position; the likelihood that a group would shift its position.
5. Cost-consciousness - the importance a group is likely to attach to the cost level of a course of action.

The data requirements of PROPDEMM are considerable, so that special care should be taken to use the best possible procedures to obtain the necessary data inputs. Survey procedures can be used to obtain the social-political information for which several methodologies have been, or are being, developed. Economic and physical projections can often be used for the environmental data inputs, while in certain cases it will be necessary to carry out specific studies or develop expert-generated information by using techniques as the Delphi.

In addition to social-political information, planners and policy makers must also consider the effects of socio-economic and physical environmental factors. These effects can be defined as the impacts of a given state of the planning system's environment on a set of values. An environmental state (ES) analytically consists of a set of environmental factors (EF's), where the latter are defined as certain aspects of the planning system's environment that are likely to have significant effects on one or more of the values that underlie the planning process. For example, in a study of the Williamette Basin (Mulder, 1974), the following environmental factors were identified in the PROPDEMM simulation.

1. Population Increase
2. Demand for Labor
3. Extent of Urbanization (in acres)
4. Expected precipitation (inches/yr)
5. Energy Demand (MWH)
6. Demand for Recreation (number of days)
7. Extent of Forest Acreage
8. Extent of Agricultural Acreage
9. Demand for Fish
10. Demand for Hunting (number of days)

Since it is not possible to specify the exact conditions that might hold for a given environmental factor, PROPDEMM provides for uncertainty by including five possible conditions for each specified environmental factor. Table II lists the conditions for each environmental factor, their impacts on the ten values, and the likelihood of occurrence in percentage probabilities. The information in the table derives from projections that were made as part of the Level B planning study. For each environmental factor, the specified condition with the highest probability is the figure that has been projected for 1980. For example, with respect to the population factor an average annual population increase of 1.5 percent has been projected. Depending on a variety of factors there is also a good chance that the increase could average 2.0 percent, or possibly 1.25 percent.

From the information presented in Table II, it is possible to abstract a large number of possible environmental states simply by taking different combinations of environmental conditions. The criteria for selecting such combinations must be explicitly stated when an environmental state is derived. For example, in Table III two environmental states are presented. E.S. I was selected on the basis of highest probability; that is, it represents the projected state of the planning environment in the Williamette Basin for 1980. E.S. II reflects an assumption that a large population increase would occur. Clearly, other significant possible environmental states could occur and would need to be considered in plan formulation.

Table II Environmental Factors and Conditions for the Williamette Basin: Impact Matrix

	WTRQ	FLOO	ECON	ESTQ	WTRS	FISH	RECR	ENER	LAND	NAVI	p
3.0% POP INCR	-3	-2	2	-2	-2	-1	-3	-2	-1	0	.07
2.5% POP INCR	-2	-1	2	-2	-1	-1	-3	-1	-1	0	.20
2.0% POP INCR	-1	-1	1	-1	-1	0	-2	-1	0	0	.34
1.5% POP INCR	0	1	1	0	0	1	-1	1	1	0	.41
1.25% POP INCR	1	2	1	1	1	2	0	1	2	0	.27
700000 LABOR DEMAND	-2	-2	3	-1	-1	-2	-3	-3	-2	3	.23
680000 LABOR DEMAND	-2	-1	2	-1	1	-2	-3	-3	-2	2	.40
660000 LABOR DEMAND	-1	1	1	0	1	-1	-2	-2	-1	0	.47
640000 LABOR DEMAND	0	1	-1	0	2	1	-1	-2	0	0	.23
620000 LABOR DEMAND	0	2	-2	0	3	2	1	-2	1	-1	.16
450000 ACRES	-3	-3	3	-3	-1	-3	-3	-3	-3	2	.22
430000 ACRES	-3	-2	2	-2	0	-3	-2	-3	-2	1	.37
410000 ACRES	-2	-2	1	-2	2	-2	-1	-3	-1	1	.45
390000 ACRES	-1	-1	1	-1	3	-1	1	-2	0	1	.30
370000 ACRES	-1	-1	1	-1	3	-1	2	-2	1	1	.15
66 INCHES PRECIP	3	-2	0	1	3	1	-1	0	1	1	.21
63 INCHES PRECIP	1	-1	0	2	2	2	1	0	0	1	.29
60 INCHES PRECIP	-1	1	0	-1	1	-1	-1	0	0	1	.21
57 INCHES PRECIP	-2	2	0	-2	-1	-1	-2	-1	-1	-1	.16
54 INCHES PRECIP	-3	3	0	-2	-1	-2	-3	-1	-2	-2	.12

Table II Environmental Factors and Conditions
for the Williamette Basin: Impact Matrix (Continued)

	WTRQ	FLOO	ECON	ESTQ	WTRS	FISH	RECR	ENER	LAND	NAVI	p
42 MIL MWH	-2	0	3	-3	-1	-1	0	-3	0	0	.31
38 MIL MWH	-1	0	2	-2	0	-1	0	-2	0	0	.39
34 MIL MWH	-1	0	1	-2	0	-1	0	-1	0	0	.31
30 MIL MWH	-1	0	1	-1	0	0	0	-1	0	0	.23
26 MIL MWH	0	0	1	-1	0	0	0	-1	0	0	.23
48 MIL R DAYS	-2	0	3	-3	0	-3	-3	-1	-2	0	.14
44 MIL R DAYS	-2	0	2	-3	0	-3	-2	-1	-1	0	.28
40 MIL R DAYS	-2	0	2	-2	0	-3	-1	-1	-1	0	.35
36 MIL R DAYS	-1	0	1	-1	0	-2	0	-1	1	0	.50
32 MIL R DAYS	-1	0	1	-1	0	-1	1	0	1	0	.21
5075000 F ACRES	0	-1	-1	-1	0	-1	-1	0	-1	0	.29
5050000 F ACRES	0	-1	-1	-2	0	-1	-1	0	-1	0	.41
5035000 F ACRES	-1	-2	-2	-2	0	-2	-1	0	-2	0	.29
5020000 F ACRES	-1	-3	-2	-3	0	-2	-2	0	-3	0	.18
5000000 F ACRES	-2	-3	-3	-3	0	-3	-2	0	-3	0	.12
1680000 A ACRES	0	0	0	-1	1	0	0	0	-1	0	.07
1655000 A ACRES	0	-1	-1	-1	1	-1	0	0	-1	0	.20
1640000 A ACRES	0	-1	-1	-2	1	-1	0	0	-1	0	.48
1615000 A ACRES	-1	-2	-1	-2	1	-2	-1	0	-2	0	.34
1590000 A ACRES	-2	-3	-2	-3	1	-3	-1	0	-2	0	.20

Table II Environmental Factors and Conditions
for the Williamette Basin: Impact Matrix (Continued)

	WTRQ	FLOO	ECON	ESTQ	WTRS	FISH	RECR	ENER	LAND	NAVI	p
5500000 FISH	0	0	2	-1	0	-3	-1	0	0	0	.23
5250000 FISH	0	0	1	-1	0	-3	-1	0	0	0	.35
5000000 FISH	0	0	0	0	0	-2	-1	0	0	0	.29
4750000 FISH	0	0	0	0	0	-1	0	0	0	0	.23
4500000 FISH	0	0	0	0	0	-1	1	0	0	0	.18
3000000 HUNT D D	0	0	0	-2	0	-3	-1	0	0	0	.22
2750000 HUNT D D	0	0	0	-1	0	-3	-1	0	0	0	.37
2500000 HUNT D D	0	0	0	0	0	-2	0	0	0	0	.37
2250000 HUNT D D	0	0	0	1	0	-1	1	0	0	0	.30
2000000 HUNT D D	0	0	0	2	0	-1	1	0	0	0	.22

Table III Environmental States for the Williamette Basin

	WTRQ	FLOO	ECON	ESTQ	WTRS	FISH	RECR	ENER	LAND	NAVI	p
				Environmental State I							
1.5% POP INCR	0	1	1	0	0	1	-1	1	1	0	.41
660000 LABORERS	-1	1	1	0	1	-1	-2	-2	-1	0	.47
410000 ACRES	-2	-2	1	-2	2	-2	-1	-3	-1	1	.45
63 INCHES PRECIP	1	-1	0	2	2	2	1	0	0	1	.29
38 MIL MWH	-1	0	2	-2	0	-1	0	-2	0	0	.39
36 MIL R DAYS	-1	0	1	-1	0	-2	0	-1	1	0	.50
5050000 F ACRES	0	-1	-1	-2	0	-1	-1	0	-1	0	.41
1640000 A ACRES	0	-1	-1	-2	1	-1	0	0	-1	0	.48
5250000 FISH	0	0	1	-1	0	-3	-1	0	0	0	.35
2500000 HUNT D D	0	0	0	0	0	-2	0	0	0	0	.37
				Environmental State II							
3.0% POP INCR	-3	-2	2	-2	-2	-1	-3	-2	-1	0	.07
680000 LABORERS	-2	-1	2	-1	1	-2	-3	-3	-2	2	.40
450000 U ACRES	-3	-3	3	-3	-1	-3	-3	-3	-3	2	.22
63 INCHES PRECIP	1	-1	0	2	2	2	1	0	0	1	.29
42 MIL MWH	-2	0	3	-3	-1	-1	0	-3	0	0	.31
44 MIL R DAYS	-2	0	2	-3	0	-3	-2	-1	-1	0	.28
5000000 F ACRES	-2	-3	-3	-3	0	-3	-2	0	-3	0	.12
1590000 A ACRES	-2	-3	-2	-3	1	-3	-1	0	-2	0	.20
5500000 FISH	0	0	2	-1	0	-3	-1	0	0	0	.23
3000000 HUNT D D	0	0	0	-2	0	-3	-1	0	0	0	.22

The environmental impact matrix provides an excellent way for evaluating "resource capabilities and expected conditions without any plan," as stated in the Principles and Standards. It also presents an extremely useful approach for developing alternative plans that are closely tied to public preferences. One can pinpoint the types of planning programs that are desirable by comparing the group value impact matrix with the environmental impact matrix. Thus, if the environmental impact matrix indicates that for a given environmental state there is likely to be little recreational opportunity, while the group value impact matrix reflects a strong interest in such opportunity, then recreation programs are clearly indicated. PROPDEMM includes formulations that provide the analyst with indices that provide comparative measures of the value impact vectors for both matrices.

The third major data component of the PROPDEMM simulation concerns the impacts from alternative plans or courses of action (CA's). The relevant courses of action are defined in terms of activity categories and a sequence of decision steps in relation to a given environmental state. The impact data is presented in PROPDEMM as part of a course of action outcome matrix, as shown in Table IV. The inclusion of this matrix makes it possible to carry out a detailed and careful examination of the consequences and feasibility of alternative courses of action in terms of value impacts. By using PROPDEMM, specific information about trade-offs for various groups can be generated.

The data presented in Table IV are estimates of likely impacts on the defined set of values that may result from the Level B plan for the Williamette Basin, CA I, and four alternative plans, CA II through IV. Since PROPDEMM assumes uncertainty both with respect to the environmental state and the outcome of a course of action, several outcomes must be defined, each being associated with a specific probability. For each course of action and a given environmental state, five outcome vectors can be read into the simulation program. These outcome vectors can then be compared with the value vectors in Table I. By comparing the information in Table IV with that of Table I one can determine how closely the expected outcome of a given plan fits the outcome desired by different interest groups. The resulting information can be used to determine the

Table IV Course of Action Outcome (CAO) Matrix for the Williamette Basin

		WTRQ	FLOO	ECON	ESTQ	WTRS	FISH	RECR	ENER	LAND	NAVI	p
						Environmental State I						
CAO	CA I											
1		1	2	1	1	2	1	3	0	1	1	.20
2		-1	1	1	-1	2	-1	1	0	0	2	.07
3		0	1	0	-1	2	1	1	0	1	1	.15
4		2	2	2	1	2	2	2	0	0	1	.10
5		0	2	1	-1	2	-1	1	0	1	2	.08
CAO	CA II											
1		1	1	1	1	2	1	2	0	1	1	.20
2		2	2	1	2	2	2	2	0	2	1	.08
3		0	1	0	0	1	1	1	0	0	0	.15
4		-1	1	-1	-1	1	0	1	0	0	1	.07
5		0	1	1	0	1	0	1	0	0	1	.10
CAO	CA III											
1		2	2	1	1	2	1	2	1	1	1	.20
2		1	1	0	0	1	0	1	1	0	0	.10
3		1	1	1	1	2	1	2	1	1	1	.15
4		0	1	0	0	0	-1	1	0	0	0	.05
5		0	1	1	0	2	0	2	1	1	1	.10
CAO	CA IV											
1		2	1	1	1	1	1	2	2	1	1	.20
2		0	0	1	-1	0	-1	1	1	0	0	.10
3		1	1	1	0	1	1	1	2	1	1	.15
4		0	0	1	0	0	0	1	1	0	1	.10
5		2	2	2	1	2	1	2	2	1	2	.05
CAO	CA V											
1		2	2	1	1	2	1	2	1	1	1	.20
2		1	1	1	0	1	0	1	1	0	0	.15
3		2	2	3	2	3	2	3	2	2	1	.05
4		1	2	2	1	2	1	2	0	0	0	.10
5		0	1	0	0	1	-1	1	0	0	0	.10

social and political feasibility of a plan, and can aid in determining what modifications are necessary in the plan.

PROPDEMM is a rich model in that it can be used to derive several kinds of information for a number of different purposes relating to plan formulation as well as plan implementation. The utility of PROPDEMM can be demonstrated by describing a programmed process that enables an analyst to determine the political feasibility of alternative plans. Other programmed procedures are being developed that will make it possible to evaluated intervention strategies that are based on stimulating participation and increasing the information available to the public. Table V presents the information output that results from the calculation procedure used to determine the political feasibility of five alternative courses of action for the Williamette Basin. The totals represent the final indices that are relative measures of the political feasibility for the plans in question. It can be seen that course of action 3 is relatively more feasible than course of action 1, for example.[16]

The indices in Table V are the final outcome of a computational process that begins with a measure of the differences between the outcomes of the several plans and the impacts desired by the different interest groups. This measure is then subjected to a weighting process that takes into account the social-political factors defined previously as summarized below:[17]

1. Measure differences between group value vectors and course of action outcome vectors.
2. Weight index by salience.
3. Weight index by probability.
4. Weight index by cost function.

---

[16] The small differences between the indices for CA's 3 and 5, and CA's 1 and 4 respectively, indicate that the formulas used in the model will need to be adjusted to increase the sensitivity of PROPDEMM.

[17] For a more detailed description of the computational process, see the author's dissertation (Mulder, 1974) or the study by Hoggan, et al. (1974).

484

Table V Systematic Political Feasibility Index (the Larger the Index Number, the More Favorable the Course of Action)

ENVIRONMENTAL STATE I

	CA No. 1			CA No. 2			CA No. 3			CA No. 4			CA No. 5		
	SIP	SAL (PFI)	PWR	SIP	SAL (PFI)	PWR	SIP	SAL (PFI)	PWR	SIP	SAL (PFI)	PWR	SIP	SAL (PFI)	PWR
Industrial	0.7	4.29 (9.)	3	0.7	4.29 (8.)	3	0.6	4.29 (11.)	4	0.5	4.29 (10.)	5	0.8	4.29 (10.)	3
Municipal	0.8	5.21 (18.)	4	1.1	5.21 (17.)	3	0.9	5.21 (19.)	4	0.6	5.21 (16.)	5	1.3	5.21 (20.)	3
Agricultural	0.9	4.40 (12.)	3	0.9	4.40 (17.)	4	0.9	4.40 (12.)	3	0.6	4.40 (10.)	4	1.0	4.40 (14.)	3
Environmental	0.6	5.00 (16.)	5	0.8	5.00 (13.)	3	0.8	5.00 (16.)	4	0.7	5.00 (18.)	5	0.8	5.00 (15.)	4
Recreational	1.0	4.91 (19.)	4	1.0	4.91 (24.)	5	1.0	4.91 (24.)	5	1.0	4.91 (19.)	4	1.0	4.91 (24.)	5
TOTAL		(73.)			(78.)			(83.)			(72.)			(82.)	

485

5. Modify index with measure of group interaction effects.
6. Calculate the feasibility index by weighting the index obtained in step 5 with power and salience.

Policy/Planning Simulations and the Principles and Standards

The description of the PROPDEMM simulation components and interactions has of necessity been sketchy. The primary aim has been to show the systems aspects of the PROPDEMM approach and to demonstrate the utility of models such as PROPDEMM in planning and policy formulation. It has been shown that a computer simulation can be very useful in integrating and systematically evaluating the large quantities of data that must be examined in comprehensive planning, as advocated by the Principles and Standards. The approach described here helps to overcome several of the limitations mentioned in the Principles and Standards with respect to the evaluation of Social Well-Being.

> In evaluating well-being effects the obtaining of detailed breakdowns and analytically useful correlations relating to various indicators, index numbers, and similar comparative statistical indicators, as well as dollar values where possible, presents many complex definitional, data, and measurement problems.

The programmed procedure that is used in PROPDEMM has been carefully related to the plan formulation process that is generally described in the planning literature, and closely follows the plan formulation steps mentioned in the Principles and Standards. For example, the specification of the "components of the objectives relevant to the planning setting" is in fact tantamount to the identification of the basic values that are to be accomplished by a plan. Similarly, the identification of "environmental states" involves the evaluation of "resource capabilities and expected conditions without any plan." Moreover, a computer simulation that allows for inputs by planners and incorporates man-machine interactions forces the explicit consideration of plan formulation procedures and can be a very useful training instrument.

Perhaps one of the most difficult tasks that confronts modern planners is that of creating some semblance of order out of a mass of complex, interrelated and often conflicting goals and activities. This is the task that has been referred to as "comprehensive planning," and represents the basic thrust of the Principles and Standards. The use of a systems approach in the form of a policy/planning simulation, including computer-accessed data analysis, is absolutely necessary in a large-scale, comprehensive planning effort. Without such an approach the basis for the planning decisions that would be made has relatively little validity or foundation. To reiterate, if the intent of the Principles and Standards is to be met, systems analytical techniques that will enable decision makers to interact with computer data banks must be used. It is only then that comprehensive evaluations will be possible.

A policy simulation such as PROPDEMM does not only facilitate the evaluation of alternative plans that must meet the data requirements established in the Principles and Standards; it also represents an excellent instrument for obtaining public participation in the form of social-political data inputs. Policy makers and planners can show representatives from interest groups and interested citizens in considerable detail how public inputs affect the evaluation of alternative plans and thereby gain additional public reactions. Furthermore, public participation can be obtained in the analysis of alternative plans, in accordance with the Principles and Standards, which states, "The trade off among alternative plans should be displayed is fully as possible for the components of all objective...," and that planners should be "making available all plans, reports, data analysis, interpretations, and other information for public inspection."

The use of complex policy/planning computer simulations requires considerable familiarity with the programmed interactions if accurate analyses are to be carried out. However, a policy maker or member of the public could, with minimal assistance, learn to interact with a simulation such as PROPDEMM in a day. There a distinction should be drawn between a general understanding of a simulation's processes and the meaning of these processes in the planning context, and a detailed knowledge of programmed procedures and formulations. Policy makers should be able to interact with computers in the use of simulation, and at the same time have the assistance of staff personnel who analyzed the presented data in more detail. With appropriate organizational arrangements and the increased application of systems techniques, comprehensive planning could become an increasingly valued reality.

To conclude, the discussion has shown the heuristic and analytical possibilities of a systems techniques involving the use of a computer simulation. Heuristically, the user of such a simulation is encouraged to approach planning and decision making in a systematic manner. He is able to observe the consequences of his own intervention in a simulated policy/planning situation by analyzing the model's outputs. Analytically, the application of a simulation such as PROPDEMM to policy/planning situations can aid in improving the decision process. Further development in systems analysis methodology promises to increase the effectiveness of planning efforts if the available techniques are used.

Literature Cited

Bauer, Raymond A. 1968. "The Study of Policy Formation: An Introduction." In Raymond A. Bauer and Kenneth J. Gergen (eds). The Study of Policy Formation. New York: The Free Press.

Cook, Thomas J. and Frank P. Scioli. 1971. "Policy Impact Analysis: A Suggested Research Strategy." In The Measurement of Policy Impacts. Conference Proceedings, Florida State University.

Coplin, William D. and Michael K. O'Leary. 1971. "A Simulation Model for the Analysis and Explanation of International Interactions." Paper presented to the National Convention of the International Studies Association, San Juan, Puerto Rico.

Coplin, William D. and Michael K. O'Leary. 1972. Everyman's Prince. North Scituate, Mass.: Duxbury Press.

Davis, Otto A. and Melvin Hinich. 1966. "A Mathematical Model of Policy Formation in a Democratic Society." In Mathematical Applications in Political Science, II. Dallas: SMU Press.

Dror, Yehezkel. 1968. Public Policymaking Re-examined. San Francisco: Chandler.

Dutton, John M. and William H. Starbuck (eds.). 1971. Computer Simulation of Human Behavior. New York: John Wiley.

Dye, Thomas R. 1972. Understanding Public Policy. Englewood Cliffs: Prentice-Hall.

Edwards, Ward. 1967. "The Theory of Decision Making." In Ward Edwards and Amos Tversky (eds.). Decision Making. Baltimore: Penguin Books, Inc.

Ferrell, William R. 1973. "Subjective Inputs and Uncertainty in Decision Problems." In Proceedings of International Symposium on Uncertainties in Hydrologic and Water Resources Systems.

Hoggan, Daniel H. et al. A Study of the Effectiveness of Water Resources Planning Groups. Logan: Utah Water Research Laboratory.

Hoos, Ida R. 1972. Systems Analysis in Public Policy. Berkeley: University of California Press.

Kane, Julius, Glan Vertinsky, and William Thomson. 1973. KSIM, A Tool for Interactive Policy Simulation. Water Resources.

Keeney, Ralph L. 1972. "A Decision Analysis with Multiple Objectives: The Mexico City Airport." In Analysis of Public Systems. Cambridge: MIT Press.

Keeney, Ralph L. and Howard Raiffa. 1972. "A Critique of Formal Analysis in Public Decision Making." In Analysis of Public Systems. Cambridge: MIT Press.

Lane, Robert E. 1972. "Integration of Political Science and the Other Social Sciences through Policy Analysis." In Integration of the Social Sciences through Policy Analysis. Monograph publication by the American Academy of Political and Social Science.

Mulder, Jim. 1974. "The Development and Application of PROPDEMM: A Computer Simulation of the Policy Process in Water Resources Planning." Ph.D. Dissertation, Syracuse University.

Raiffa, H. and R. Schlaiffer. 1961. Applied Statistical Decision Theory. Cambridge: MIT Press.

Raser, John. 1969. Simulation and Society. Boston: Allyn and Bacon.

PUBLIC PARTICIPATION

Ann Widditsch
Consultant in Public Affairs
Seattle, Washington

I note that I am the only woman here, except for one of the observers, whom I am glad to see--thus, I am both the token woman and the token citizen. This is no accident. Middle-class, middle-aged women like me form the bulk of public participators, because we are about the only ones who have the time and money to do it. This is changing now (and, as you can see by my biography, the change is affecting me, too) because more and more women are working, entering professions, or doing other things. Thus, in the future, even women won't be able to participate so easily. If we don't figure out some better ways of inducing participation from all parts of society, we will end up with no participators at all.

Some of you have heard me talk before. I hope not to repeat myself, but I may, because several years of additional experience have not changed my ideas very much.

What I propose to do is say something about citizen participation in general, and how it is addressed in the Principles and Standards, then something about the problems of public participation and how they might be dealt with, and finish with some miscellaneous advice.

I come from the firing line of citizen participation, I'm not a theoretician. My academic training is not in planning or sociology or psychology (not to mention engineering). I'm just out there doing it as a citizen, like many others.

But I have been doing it for a long time. At present, I am supposed to advise the State Department of Ecology as a member of the public on the State Ecological Commission, advise the Bonneville Power Administration as a member of the Bonneville Regional Advisory Council, advise Seattle City Light as a member of its Policy Advisory and Rate Advisory Committees, and advise the Seattle City administration as a member of the Mayor's Environmental Impact Review Committee. I won't go into further detail, but I believe I'm about as active a citizen participator as you can find, considering the many years of committee meetings, hearings, and other such activity.

In addition, now I must function partly in that kind of role and partly on the other side as a member of a Task Force for Citizen Participation, planning for water resources and waste treatment for a large part of the Seattle area--with a population of about a million, and a grant of $1/3 million from the Ford Foundation to help us do it. And let me tell you that we are nevertheless having a difficult time of it. We participate personally as citizens, and we help elicit participation from other citizens, acting as go-betweens between the citizens, the consultants, the elected officials, and the bureaucrats.

There are people working on the theory of public participation, and I wish them well. Theory or academic approaches are just not my cup of tea, as practical experience is. That brings me to my first piece of advice: Get some practice as a citizen yourself. Be a citizen participator in something you're interested in--saving a historic building, changing a highway route, influencing the school board or the city council. If you find it hard to spare the time, that should add to your respect for those who manage to.

Citizen Participation Today

The recently burgeoning interest in public participation is, I believe, a developing part of our struggle for democracy, or if you will, a part of the effort to control our destinies in this country. It's one attempt among many to make our government work better. Citizen participation is one way to deal with bureaucracy, which is so hard for citizens to affect. Elected officials come and go, but the bureaucracy goes on.

Interest in public participation is even related to the recent change of of presidents, in my opinion. Who of us, until recently, ever anticipated a serious attempt to impeach a president during our lifetimes? I believe that Watergate (in the broad sense of everything that surrounds it) has caused a cataclysm that our society will be long in recovering from. Perhaps that is the wrong metaphor. Perhaps an earthquake is a better one--the immediate shock has now passed, but giant forces are lying underground in new, shifting configurations. It may be generations before we realize what this earthquake of 1974 meant--and means--to us.

Other factors are both signs of and causes of change, like the advent of revenue sharing, and the apparent turn of Federal interest from large cities back to States and Counties.

Wherever it came from, and though it is not uniformly defined, citizen participation has become a standard Congressional directive in new legislation, for example in the Water Pollution Control Act Amendments of 1972, an area in which citizen participation had hardly been traditional over the years. Local governments, too, are including such directives in new legislation. I suspect that many bureaucrats are not happy with this trend. How can experienced professionals welcome the meddling of troublesome amateurs in their business, no matter how well meaning they are--and aren't they always? Nevertheless, Congress directs, and bureaucrats have to cope, whatever their inclinations and problems.

The Principles and Standards themselves are a response to changing public ideas. They have a long history, briefly reviewed in the Environmental Impact Statement. Gary Cobb discussed this history last December in connection with a Pacific Northwest River Basins Commission meeting--at which, by the way, I may have been the only citizen. Possibly many of you here have heard about it.

This history shows the significance attached to the Principles and Standards and is an indication that they aren't settled for all time--they will change again. Citizen participation is given rather perfunctory treatment in the Principles and Standards, especially in comparison with some of the other items. However, according to Mr. Cobb, it was given considerable attention in the drafting and review--and caused numerous, of the almost 12,000, comments that were received. He said that the area was strengthened after the comments from the public. He also said citizen participation is crucial to make the Principles and Standards work, that they don't solve how you get participation, but that it is very important to get it.

Environmental Movement

At this point I want to say something about the environmental movement and its effect on the public involvement scene. It has been said that the environmental honeymoon is over, and maybe it is--but the marriage isn't. We still have to figure out how to get along together from now on, because there's not going to be any divorce from the environment. A lot of the demand for citizen participation comes from environmentalists, and frequently it is based on their desire to stop something they don't want--and maybe something you do want. Naturally, this irritates you, and you feel that they are being devious, but there is nothing intrinsically wrong with it. A person uses the tools that come to hand, and if citizen participation has been lacking in the planning process, that is a legitimate complaint. Litigation has always worked this way (relying on the importance of proper procedures), and has been fairly respectable over the years. The other side, the developmental side, has always used these kinds of techniques freely. It's an accepted way to do things--especially if somebody on your side is doing it. It's part of the way government works.

One of the most important effects of the environmental movement has been to help open up the process, for example as is required in the National Environmental Policy Act. The idea is to think about and exhibit the consequences of what we do before we do it--before it is too late. Obviously this can be a nuisance, and there are undoubtedly ways to improve the process, but can any reasonable person quarrel with the goal? Yet, this was seldom being done before NEPA, and I'm afraid it's not always done adequately now, either. Modern life is complicated--we have to take things into consideration that we didn't used to. This trend will continue, not abate.

Paranthetically, but I believe importantly, I want to emphasize the seriousness of the environmental challenge. I don't want to get into a discussion, much less argument, on this subject, which is not what I am supposed to address. But please realize that most environmentalists are not persons who wish to be lone hikers in acres of wilderness needed for some other purpose, but are seriously concerned about factors that could affect the survival of humanity. We don't know what the thresholds really are, for example, for DDT or mercury or CO_2 or radiation in the environment; or for some needed plankton in the oceans or bacteria in lake bottoms. That's why many (including me) urge caution in tinkering with the works. Just because disaster hasn't struck yet doesn't mean that the irreversible change that leads to it isn't already under way.

It's interesting that in spite of the new emphasis in the Principles and Standards on environmental quality, the approach to it is rather gingerly.

For example, the statement about the environmental quality objective says that "As incomes and living levels increase, society appears less willing to accept environmental deterioration in exchange for additional goods and services in the market place" (Page 33, emphasis mine). And in the part on formulation of alternative plans (p. 100), " . . . given . . . the general uncertainty with respect to future preferences for the environmental quality objective, a single specified level of achievement or need satisfaction for any given component is not likely to be acceptable through time". Note, too (p. 103), the great care prescribed for adoption of a "no development" alternative. Other alternatives also need great care.

Requirements in Principles and Standards

Wherever the demand for public participation comes from, it exists, and the requirement appears in Principles and Standards, summarized on the slide. "Participation" is a component of plan formulation under the discussion of standards, and since it is short, I will quote it (p. 96):

> "The actual derivation and identification of components require several different approaches. An initial point of departure is the national and regional economic analyses and projections provided by the Council. These will be useful in a first-cut definition of the economic parameters of the components of the objectives. More detailed definitions will require in-depth consultation with Federal, State and local officials familiar with the planning setting. Direct input from the public involved at the local and regional level is important, and will be accomplished by:
>
> a. Soliciting public opinion early in the planning process;
> b. Encouraging periodic expression of the public's views orally, and recording their opinions, and considering them;
> c. Holding public meetings early in the course of planning to advise the public of the nature and scope of the study, opening lines of communication, listening to the needs and views of the public and identifying interested individuals and agencies;
> d. Making available all plans, reports, data analysis, interpretations, and other information for public inspection.

> Efforts to secure public participation should be pursued vigorously through appropriate means of public hearings, public meetings, information programs, citizens committees, etc.
>
> Definition and specification of the components of the environmental quality objective will require direct consultation with groups identified with environmental concerns as well as with those groups within a planning setting whose actions have significant impacts on the environment. A broad spectrum of public groups and interests must be considered and consulted in the identification of the components".

The progression to participation is interesting. The paragraph slides quickly from the national and regional economic analyses of the Council, to consultation with Federal, State and local officials, to input from the public. And it ends with special attention to environmental groups.

Mr. Cobb described the citizen participation process recommended as "iterative", but I'm not sure it is quite detailed enough to be so described, though his description probably gives a clue to its legislative history within the Water Resources Council. That's what they expect it to be. In any case, it's hard to take issue with what's here, short as it is. Note words like "early" in the process, "periodic" expression, efforts should be "pursued vigorously".

Why Citizen Participation?

Just what do we mean by citizen participation, anyhow? Is it supposed to defuse opposition, build consensus, seek citizen advice, give citizens a voice, or give citizens control? The public is likely to reject the first and second--if they recognize those goals--and you would probably reject the remainder. I like the sound of the first two, myself (Of course, this list is just an arbitrary division by me). For example, couldn't citizens help you identify impacts and collect information for the new accounts?

Whatever the role of the citizens, it should be understood and accepted by both sides. What kinds of citizen participation will further the kind of planning envisioned in the Principles and Standards? If this means citizens will have a practical role in the planning process, what is it? This is a message that might be sent back from this course to the Council--more definition of the role of citizens. That should help determine what you do.

For, most important, what administrative and logistic things have to happen to allow these roles to be assumed? Each kind of citizen participation has implications, and what do you have to do to make it happen? This will take serious thought and consideration, and also time and money.

How to get citizen participation

So, with the directive from the Principles and Standards, what next? I can't bring you a message about some technique or strategy to plug in, a recipe to follow, even though the Principles and Standards themselves are an attempt to frame a recipe that will always produce the right results.

Like the environmental honeymoon, the citizen participation honeymoon is over--if there ever was one. The public has seen that participation often doesn't result in what they want, it can be excruciatingly dull, it is time consuming, and it is work. Even so, there are still some people out there who want to take part. Bureaucrats who started out in good faith to do a good job are disillusioned because it's hard to get people to come to meetings or take part in any other way, and in the end they are likely to complain just as much as if they hadn't had the chance.

Even though the honeymoon is over, again, the marriage (and the Congressional directives) isn't. I am not disillusioned because I never expected great things. Like any type of governmental reform, it's a constant struggle, and any one law or regulation or series of them may not make much of an improvement--may even worsen the situation. We just have to keep on trying to make things better, fairer, more sensible and sensitive.

In the real world, how do decisions finally get made? In the case of water planning, I'd say that decisions are generally made by the agencies, but are subject to a political veto. This is hard on the citizens because they often can't see that they have had any effect on the decision. It's also hard on the planners, because they sometimes get overruled by politicians. But what's wrong with that? It's how we do other things, and how our government is supposed to work. We know every decision is not necessarily the right one, but we believe that more often than not it is, and that this is the most suitable way to make decisions--it's a fact of life.

The Principles recognize this in Section II Objectives (p. 6): "The priorities and preferences of the various individuals affected will vary, and accordingly, there will likely not be full agreement among all affected on whether certain effects are beneficial or adverse or on the relative tradeoffs between objectives". And they go on to say, "However, when any plan is recommended from among alternative plans, there is an implicit expression of what is considered to be the affected group's priorities and preferences".

Citizen Participation Problems

What makes it so hard to get citizen input? The public has some problems that contribute to the difficulty, and the agency also has some problems. First, some of the citizen problems:

Most of us, of course, just want a peaceful life. We want to work, play, enjoy our families, relax, travel or whatever. Participation in water resources planning is a rare leisure taste. Inertia is the first problem in getting citizen participation.

Even when and if interested, citizens operate at a big disadvantage: on their own time, with their own money, without hired expert lawyers, engineers, lobbyists, or public relations persons. The proposer of a project, for example, has a big advantage: he has studied the site, made an evaluation, figured out the economics and the foregone opportunities. He knows what he wants to do and why. All this is new to the citizen or local official who wants to make an evaluation on his own. The proposer reveals what he is required to, and what he feels is in his best interest. The citizen must research the rest, with few resources at his command. These are some of the reasons public outcry comes late in a project.

You can help with all these problems. You can give some logistic support to the citizens for ease and independence. You can schedule meetings so they can come without missing work. You can help with communications and experts. But you should do it without making the citizens captives--they wish to remain volunteers, not to change their status.

You can also help with the problem of citizen understanding of processes by which things get done in government. Even sophisticated people may be quite ignorant in this area. Don't take for granted that they know anything--but don't make them look foolish or stupid.

Another citizen problem is that there are so many things to participate in. I mentioned some of the things I'm involved in. Now here are some of the current things I am not participating in and should be (and would like to be): hearings of freeholders writing a new Seattle City charter, meetings on master programs for shorelines management on three different government levels, establishing new trolley lines (yes, trolley--and as a result of citizen demand), placement of new bus shelters, local community council, state planning to year 2000, planning for the various nearby national forests, planning for our three national parks, planning for the Skagit as a wild and scenic river, and planning for a bicycle trail within Seattle. Those of us who are active are spread so thin! Try to understand why we might not come to your meeting sometimes. In fact, the League of Women Voters of Washington has a contract to study this proliferating problem and make some suggestions about how to deal with it.

Now I am going to dispense some more advice, which is not exhaustive, and none of which is particularly original or earth shaking. But I hope it might meet some of these problems.

Helping the Citizen to Participate

What is needed:

- Be pragmatic
- Start early
- Plan carefully
- Know what you want
- Be flexible
- Provide information
- Work for broad participation
- Make it convenient
- Get publicity
- Be organized, but informal
- Report conclusions
- Liaison with local and other agencies

The first may be the most important: Be pragmatic. Try new things, do a lot of different things. The RIBCO Task Force has used public meetings, TV programs and related questionnaires, surveys, newspaper ads, displays, speeches to groups, and publications. Some of these techniques seemed like better ideas to me than some of the others, but we've tried them all. Surely they don't all get the same people, even though there must be some overlap. And we are far from satisfied with the amount of input. Doing something again and again and failing just because it worked the first time is wasting your time. Try something different and stay loose.

One of the questions that often comes up is, Who is the public? Sometimes it is phrased, Who are the various "publics", a word I resist. It is obvious that the public is composed of many different kinds of people. But they keep sliding around into different categories, just when you least expect it. When is person A a hard hat, when is he a fisherman, when is he a night school student, a father, a homeowner? You don't need an expert to tell you that people in a town of 3,500 dependent on a sawmill are going to react differently to things than residents of an upper middle class suburb. But you should remember the difference, and think about different ways to address those people. And even in the small town there will be bankers, students and bums, and in the suburb there will be small businessmen and servants.

Start early. Here I echo the Principles and Standards (though I was saying it before they were written!). Many have said that the place for the citizens is in defining their goals and values, into which then can be fitted the various projects and objectives. It would be nice if we could get people to do this, but it is extremely difficult. Let's let people know what we're thinking about, so they can figure out some response, the sooner the better. If their response is not immediate, that too is a fact of life.

Plan carefully. This really goes with "be flexible", because while you must plan, you must also be ready to change if plans aren't working. From my experience, schedules are seldom met--for anything (For example, as a citizen I am an expert in not meeting deadlines). So let's try to be more realistic. Part of this problem of lateness has been that the whole citizen participation effort has been inserted so late in the process that there has been little time for adequate preparation and publicity.

Know what you want. This doesn't mean you know you want a dam! It means, What kind of response do you want from citizens? As mentioned earlier, there are various levels and kinds of participation, and whereas people may be irritated if you don't take their advice when you ask for it, they will be enraged if you indicate that somehow they, the people, are going to make the decision and then in the end they don't get to.

Provide information. Again, think this through. Do you need to distribute a multi-volumed basin study to hundreds of people? Will a one-page meeting notice be enough? How will either be perceived by the public? In most cases, probably a medium-sized document is appropriate for the broadest use, with enough copies of the full study so that those who wish have relatively easy access to it. Nothing is more destructive of credibility than the feeling--or charge--that information is being kept from the public. In this connection, you should be especially solicitous of the media. Of course reporters don't want to read the multi-volumed study, or maybe even the medium-sized document, but make sure they get the latter and are aware that the former is conveniently available to them.

Work for broad participation. Everyone knows that citizen participators tend to be of certain kinds (often much like me, as I mentioned earlier). You and your agencies alone are not going to be able to change this. But what you can do is: (1) Be sure to issue invitations and publicity broadly (including, for example, labor and minority publications); (2) Make special efforts such as personal telephone calls to get persons needed for broadness of participation, special viewpoint, community position, etc.; and (3) Be sure that the atmosphere of meetings or other occasions is cordial towards all persons.

Make meetings convenient for them--not necessarily for you--and comfortable. Time is one factor--can working people come? Location is another--is it easy to find, is there parking, public transportation? And the type of meeting room is a third. Does it promote free exchange between speakers and audience, if that is the format? Is there room for chairs to be placed in a circle? To divide into small discussion groups? Is it possible to have coffee or other refreshments? Or are the officials up on a stage, behind microphones (an excellent way to help create an adversary, we-them feeling)? The atmosphere should be friendly, but businesslike--not forbidding. This may be difficult within some kinds of buildings.

Get publicity. My impression is that this is seldom given enough attention by agency people. Establish (or be sure that someone in your office does) a personal relationship with the working press. This may take a long time, but it is worthwhile. Among other requirements, you should never mislead them, and you should always let them know early about something that is happening and then remind them again just before it happens. Send them news releases and other pieces of paper, but don't make the assumption that they will have read any one piece, or kept it (though every now and then, they will). Don't forget about other kinds of publicity--a newletter of your own, organization newsletters, newspaper ads, posters or notices, telephone trees. Consider what forms of publicity are appropriate for the area. Make your notices interesting, even seductive, not officious.

Be organized but informal, informal but structured. If you come to a meeting and say, "What do you citizens want?" people are going to be at a loss. This really goes with "know what you want" and "be flexible". Have a plan in your mind of how you're going to get from A to B, review it frequently to see if it is producing the results you wanted, and make the changes indicated--but don't make changes lightly.

One of the most impressive examples of this I have seen (and I'm sure it saved the program from total disaster) was at the first big community meeting of Seattle, a Mayor- and Council-sponsored effort to get Seattle citizens to think about goals for the City. On this occasion a carefully planned program, including some high-powered guest speakers, was jettisoned in the middle because of rumblings from the attendees (close to 2000, I recall) about "We don't come to listen to these people, we came to talk and make decisions ourselves". That's flexibility!

Don't have testy officials at meetings; and ban technical or government jargon. You might consider an outsider as meeting chairperson. You can get other help from outsiders, too--publicity, for example. Have experts available to help, but don't let them dominate meetings. You can answer questions, but don't argue or justify. Visual aids are good, but don't be overwhelming.

Report conclusions. Of course you should be reporting back all through the process, with feedback between and among the public and the agency. As a minimum, all the alternatives should be displayed for the public, and the consequences that flow from each. This shouldn't be hard, because this is what you are supposed to be doing. This display of alternatives is part of increasing openness in government. And, in addition, the government's desire that all issues will become increasingly visible to the public including better understanding of the basis on which a decision is made. This has not always been true in the past.

And, finally, tell the people what you have decided. Tell them how they influenced the decision. The Principles and Standards specify (p. 107), "The basis of selection will be fully reported upon indicating all considerations made in the selection process". But it doesn't say to whom it will be reported--I can imagine it going up through the various levels of government with little notice to the public. Why not send letters, for example, to the citizens that were involved, whom you of course have on your mailing list? Anyhow, be brave and tell them the truth, don't let them read it in the papers.

Liaison with local and other agencies. How does local government enter in--how do they get the money, time, staff? Their entry into the process should be structured to make it easy for them; they should be more than silent observers. Get elected officials involved if you can, too. Communication and education are needed. It is almost as hard for local governments to cope with you as it is for citizens. And don't forget about a miscellaneous of other agencies, too.

As Dennis Lundblad, once of the Puget Sound and Adjacent Waters Study and now of the Washington State Department of Ecology, who ran workshops on the Puget Sound Study in twelve (12) counties for six months said, "Start public participation early; seek to budget for it well in advance; plan to include all who are willing; build in clear guidance for participation; strive hard for a cross-section of interests and keep people's interest alive. Plan to spend extra time--and patience--to consider and use ideas that people take time to develop" (At Conference of State and Federal Water Officials, Des Moines, June 1971).

Techniques of Conducting Public Meetings

Now, here are a few thoughts about techniques--by no means exhaustive. You've probably already deduced that I'm prejudiced in favor of meetings as a way of doing things. They are what I'm familiar with and most involved in. I recognize that there can be great merit in, for example, television or radio call-in shows, newspaper questionnaires, surveys, or other techniques. I talk about what I know most about and have most experience in, so take my prejudices into consideration. I would urge you, though, not to be seduced by over-sophisticated or over-technical methods, something that technically trained people seem to be particularly susceptible to. It is questionable whether there are any real shortcuts around person-to-person contact.

It's interesting that public hearings have generally been changed into public meetings. Is that distinction without a difference? Are they still conducted the same, with the Congressman first, then the Governor, the Mayor, the mosquito control commissioner, and then the general public? That's the impression I have. Try some other ways to do things. Alternate pros and cons, for instance, or let the public go first. Or take people in some other arbitrary order. I can see the rationale for the traditional order, but I'm sure you've noticed the effect on the disposition of your witnesses when they have to wait till 11:00 p.m. to make their statements.

Some other thoughts on meetings--should the hearing officer ask questions of the testifier? Should witnesses be able to ask questions of the experts present? Should a sort of cross examination be allowed? What about using a public inquirer? All effort should be made to avoid intimidating persons who are speaking, but the object of the meeting presumably is an exchange of information and opinion. I would like to see these techniques experimented with, to see whether any of them (or others) seem to increase the effectiveness and representativeness of meetings.

As I mentioned earlier, I have experience with citizen advisory committees. They are useful, but should not be the whole citizen participation effort. Using a committee to help elicit participation from the rest of the citizenry is an attractive idea, but we find in RIBCO that it's about as hard for us citizens to get the other citizens involved as it is for the agency itself. By using at least those citizens you are that much ahead. It is hard to avoid making such a committee a mouthpiece for the agency it is involved with. Citizens committees need some independent staff and funds to be able to do things.

Some swear by surveys and questionnaires. I would say that surveys are likely to be designed by an expert to make a scientific sample of opinion, while questionnaires may be a more amateur effort. You or I might write them, and they will tell us what the people who come to a meeting, or those who bother to fill one out in a newspaper, think. They will not pretend to represent the whole population of an area. Surveys seem to be not quite citizen participation, but more like an election, you just leave out 98% of the people. In either of these techniques it is important to be sure that the language used in asking the questions is not loaded one way or another. This is very hard to do, because we all have our subconscious assumptions that affect the way we express ourselves, even if we are trying to be neutral.

In short, new ideas are always being developed. Try them out, give them a chance. But don't expect miracles!

Agency Problems

- Staff
- Budget
- Timing
- Changing Public

Earlier I mentioned agency problems. I'm sure I don't need to tell you about them, but let me mention some of the ones I see. Budget is undoubtedly the most important. A certain amount of money (and I don't know how much--some have mentioned figures from 25-40% of the planning budget) is essential to do a reasonable job or public participation. I know that this money is very hard to get, in spite of the Congressional directives. It's a lot easier, though still hard enough, to get money for hardware. I have no solution for this problem. I would suggest that a few successful citizen participation efforts could create a constituency that could help with getting this money through the budgeting process. Imagination and innovativeness in figuring out techniques could help a lot, too. After all, many voluntary organizations exist and thrive on minuscle thoughts--perhaps you could learn from them. I want to recognize the problem, but you can't use it to get off the hook!

Staff, of course, is primarily a budgetary problem. A special coordinator for public participation would be very desirable and helpful. This person would gain expertise and knowledge of the community over time, and would become ever more valuable. Another factor about staff is the negative outlook of some people to change their ways, and maybe in some cases you just can't, but have to go around those people.

By timing I mean getting your citizen participation efforts under way at the appropriate time and keeping them on schedule to fit in with the planning. This is very difficult, especially because public participation tends to get left behind in a crisis. This has to stop!

Another problem for the agency is that the public changes. It changes not only in bodies--people move away, die, get born, start or stop working, etc.--but in ideas and outlook. This makes us unpredictable and troublesome. There is no continuity among citizens or elected officials. Staffs change much more slowly. So the staff of the agency has to keep starting over. You just have to do it, it's another place to stay loose. Citizen participation is an untidy business for bureaucrats--it's so messy, working with people.

I have a few other miscellaneous thoughts and pieces of advice. One is the importance of face-to-face contact. I told one of my clients they didn't go out to lunch enough. It doesn't have to be lunch, of course, but such a rather social, but still businesslike and noncommittal (everyone pays for his own) occasion provides an opportunity to get acquainted in a somewhat congenial, non-threatening atmosphere. Think how much easier it is to call or write to someone you have visited personally. Don't just rely on your constituency. You may establish a relationship even with someone otherwise known as the enemy. I believe that nothing but good can come of this. Otherwise each is a faceless monster to the other.

My next thought is partly a reflection of my somewhat old-fashioned outlook, I know: read the newspapers! This is anything but a waste of time. You'd be surprised how much you can learn about the pulse of an area even from a pretty bad newspaper, which many of them are. If you are concerned about some water resource activity in a certain area, you should read the newspapers from that area all the time. And I don't mean just getting a clipping service--you need to get a feeling for what is on those people's minds, not just what the county commissioners said at the meeting about the flood control plan. That, too, but that's not all. You may say, well, what about television? By all means, watch television. But the time for television news is so short, and it is so ephemeral--a few blinks and you've missed it. We will be in deep trouble if television ever really kills off the newspapers.

When I started thinking about this talk, I went back through my report on the Puget Sound Study workshops. From one to nine workshops each were held in the twelve (12) counties around Puget Sound during a period of about six months in 1970-71. At the time we were disappointed that more people had not participated, as seems always to be the case, but upon reflection I'm hard put to think of any effort known to me that was more effective in direct communication, feedback, and response.

In many of the counties, a wholly new group was constituted and assumed a real existence of its own. At the time, it was my hope that some of these groups would continue, to be citizens committees on water resources. I think this could have happened if there had been any followup. But, though this is one case where it is easy to show how the citizens affected the final document, the study report went into the maw of the governmental process, and few, if any, of these citizens have the slightest idea of what's happening to it, or how their voices affected it.

One other point about the Puget Sound workshops: official written comments were asked for from the various counties. Some counties produced them, and others didn't; some were synthesized, others were just a collection. Other, independent written comments from the citizens were encouraged. The written comments, both official and citizen, were generally impressive. I still remember some of them vividly. Of course, it's hard to get people to do this. but it's worth trying, because it is very valuable. They have to think about it, not just talk off the tops of their heads (Though I want to make clear that oral comments, meetings and testimony were also taken into consideration).

Another thought is the importance of mailing lists. You probably all have one to begin with, which includes Congressmen, mayors, legislators, county commissioners, and officers of some kinds of organizations. That's fine, but it's probably not enough. If you have a citizens committee, have all of them who are willing take a look at the list and suggest changes and additions. Make a conscious effort to think about who should be on it and find their names and addresses. Don't ever regard it as a finished product. And be sure that it is maintained. Do you know that half the people in Seattle move every year? I assume this figure is not greatly different elsewhere. If you want to divide the list for different purposes, fine. This is easy to do with modern equipment. But it is a good idea to have one person with responsibility for the list, because the right kind of person who does this will subconsciously learn names and addresses, notice errors, note appropriate additions in the newspapers (another good use for newspapers) and so on.

Finally, don't expect gratitude from the public for your yeoman efforts for citizen participation. And there is no guarantee that a good citizen participation effort will prevent later trouble. You know, people think you work for them. Try not to whine. Stand up and take your lumps, and you will be respected for it.

Where do we go from here?

What is the future direction of citizen participation? I have talked about the various degrees of citizen participation earlier. Tom Dinell in his paper on participation posits two wholly separate and different types of participation (rather than the traditional ladder): consultation vs. self-management. His division is appealing in some ways, though I feel it is largely irrelevant at present. Consultation is the sort of thing we have been talking about. You ask people for their opinions and then take as much, or as little, as seems appropriate.

Self-management is just that. The public actually makes the decisions. Sometimes we do this. Legislation by initiative and referendum is an example. We could have a referendum on almost everything, as is the custom in Switzerland. I understand that a great many of the Sundays there are devoted to referenda on various national and cantonal questions. This is awfully clumsy except in special cases, or at a very local level.

While stopping short of actually endorsing a move to self-management, Dinell seems to favor it. However, he maintains that it can come in planning no faster than in other areas of life. In other words, we can't have self-management in planning and not in the work situation, or the school situation, or the family situation. All this would mean a really big political change, which does not appear to be on the horizon.

I don't think you have to wait nervously for people to take over all the decision-making on water resources planning, though I think some of you are concerned about just that. I just don't think that many people are anxious to jump into making all these decisions. They see the pitfalls of doing things this way.

People do, though, want a more direct say in what affects them, and this is where we are now. We vote for maybe 20-30 candidates for various officials a year, and it is seldom that we can vote for them on the basis of what they will do about water resources. They come in a package with too many other issues. People need to be able to talk to the bureaucrats, the planners, and know that they are being heard.

Specifically, with relation to the Principles and Standards, a popular publication needs to be developed. What do the Principles and Standards mean to citizens? If the public is expected to have input into this framework, they have to know what it is. National economic development, environmental quality--what parameters, what methods will be used to determine these? Citizens have to be able to see where they fit in.

A few years ago at a citizen meeting I heard a man say he had lived in the area 20 years and had never taken time to be a citizen--now he wanted to. "Why can't we have a day a month off the job to be a citizen?" he said. Maybe this is an idea whose time will eventually come. People are frequently given time off for jury duty or military service. This is not something you are going to do anything about, but it's a possible idea for the future.

Citizen participation, like the environment, won't go away. We might as well figure out how to cope with it. It's an art and an attitude, by bureaucrats, citizens, and elected officials. It's one of the ways we keep experimenting with our democracy, trying to make it work better.

Bibliography

Public Workshops on the Puget Sound and Adjacent Waters Study: An Evaluation by Ann Widditsch, U.S. Army Engineer Institute for Water Resources, Alexandria, Virginia, June 1972 (IWR Report 72-2). Available for NTIS.

The Susquehanna Communication-Participation Study by Thomas E. Borton, Katharine P. Warner, and J. William Wenrich, U.S. Army Engineer Institute for Water Resources, Alexandria, Virginia, December 1970 (IWR Report 70-6). Available from NTIS.

The Grass Roots and Water Resources Management ed. by Linda McKenzie, State of Washington Water Research Center, Washington State University, Pullman, Washington, 1972. (Report No. 10).

Public Participation in Water Resources Planning by Katharine P. Warner, National Water Commission, Arlington, Virginia, July 1971. Available from NTIS.

An Approach to Public Involvement in Water Planning by Nancy Leifer, Montana Department of Natural Resources and Conservation, Helena, Montana, February 1974.

"Participation: The Impossible Dream" by Tom Dinell, Director, Pacific Urban Studies and Planning Program, University of Hawaii. Remarks delivered to a joint meeting of the American Instituted of Architects and American Institute of Planners, Hawaii Chapters, February 21, 1974.

PUBLIC DECISIONMAKING PROCESSES

Henry P. Caulfield, Jr.
Department of Political Science, Colorado State University

The lectures in this series, so far, have been aimed largely at furthering technical-professional understanding of the Principles and Standards and of the technical-professional means for their implementation. This lecture focuses on public decisionmaking processes, and the role of lead planners and field decisionmakers in those processes. This lecturer believes, on the basis of substantial governmental experience in the water field as well as academic study, that planners need to relate themselves as effectively as they can to public decisionmaking processes.

As technical inputs to the decisionmaking process, John Keith discussed the analysis of tradeoffs in connection with alternative plans and James Mulder gave you the present results of his research on the possibilities of systematic political analysis and its use in judging political feasibility. To highlight the role of the public in relation to the government planner, Ann Widditsch, a veteran of participatory engagements on behalf of the public, has discussed public participation.

This lecture identifies with the planner and his role in government. Its basic purpose is to advocate that planners who have, or will have, planning leadership responsibilities, see their role as more than that of technical-professional planners. This advocacy involves four theses which government planners will either accept or reject.

Clearly, the end result sought in planning is not just plans, but action upon plans and their ultimate realization on the ground in public use. To achieve this end, lead planners must be willing to expand their own conception of their roles:

> Thesis #1: Lead planners must engage, not just in technical plan formulation and analysis, but also in political participation in public decisionmaking.

Political participation! For many planners, a call to political participation may be frightening and engender an immediate negative reaction. But the planner needs to be quickly assured that political participation in this argument does not mean partisan political activity with its hoopla in conventions and with its insecurities of tenure in office holding. It does not mean giving up Civil Service status grounded in technical-professional ability. But it does mean acquisition of the know-how of politics and participating actively in its processes, but only in the limited way necessary for a lead planner or field decisionmaker to obtain action on plans, and thus help assure their realization.

In this context, what is meant by "politics"?

> Politics is the process by which a society makes authoritative decisions about the allocation of values[1/].

Each of the objectives in the Principles and Standards represents a societal value different from the other. Alternative mixes of these values clearly represent different "allocations of value". As a lead planner or field decisionmaker, one cannot escape his formal relationship to the process of making "authoritative decisions", but in failing to take an active, positive leadership role, the lead planner will often frustrate in reality, the whole potential decision process. He, personally, may cause nothing to happen from his best technical-professional planning efforts if he does not participate actively in the process of decisionmaking.

If a planner has substantial training in economics, he may ask: Do not the processes of a free enterprise economic system, and its simulation in governmental economic efficiency analyses, provide the determinant of public decisionmaking that most properly should allocate value in American society?

[1/] See David Easton, "A Framework for Political Analysis" (Prentice-Hall, Inc., Englewood Cliffs, New Jersey; 1965), pp. 50, 96-97.

Yes, say many economists who think of themselves as normatively advocating "consumer sovereignty", in contrast to what will be called here "societal sovereignty", as the ultimate decider. This is the basis of their advocacy of "discount rates" in government economic analyses comparable to the opportunity cost of capital in the private sector. These economists would uphold the "economic market place" as the better arena for allocating value than the "political market place".

Multiobjective planning clearly denies the propriety of governmental economic efficiency analysis in terms of tangible benefits and costs (i.e., a simulation or quasi-simulation of private sector, value allocation processes), as the sole value-analytic basis of plan formulation, evaluation and decision. The propriety of NED as the sole objective of water and related land resource planning is denied.

There are several reasons why economic efficiency analyses in terms of tangible benefits and costs should not be the sole determinant of public decisions[2/]. Only one needs to be identified here. This reason stems from the problem of "commensurability" in value measurement. In both the Green Books of 1950 and 1958 and Senate Document 97 of 1962, this problem was resolved, in formal terms, by the distinction between "tangible" and "intangible" values. Tangible values meant values expressed in monetary terms and intangible values meant values, incapable of monetary valuation, and capable of expression - if at all - only in physical or other measurement terms.

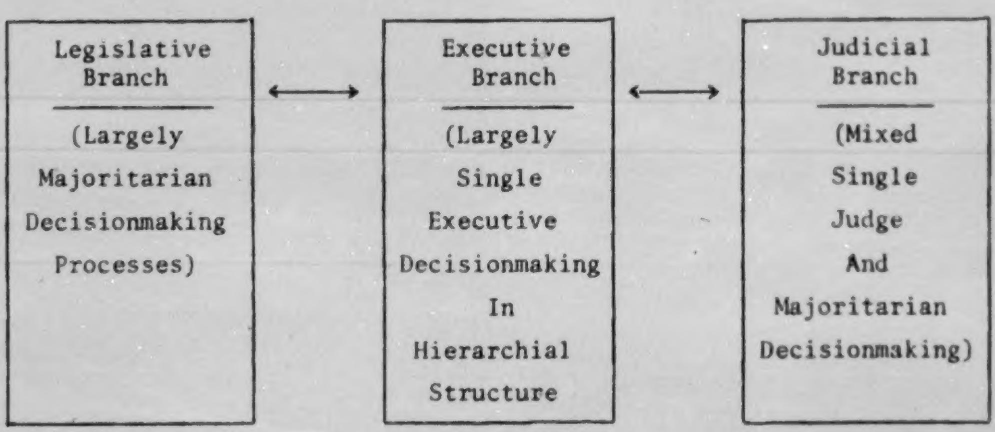
In the Principles and Standards this problem is handled, implicitly, by putting those components largely to be measured in monetary terms (by reference to market or simulated prices) in the NED and RD accounts and these components whose values cannot be measured in monetary terms in the EQ and SWB accounts.

[2/] These reasons in the context of a critique of normative economic thought or "welfare theory", relate generally to its application in the real-world of market imperfections of various types. They relate also to considerations of equity in the distribution of income among persons now living and between present and future generations.

Thus, tradeoffs between NED and EQ values, in the light of RD and SWB effects, can only be decided by the political market place. Why? Because there is no one analytic answer capable of being determined by applied professional economic analysis!

What, briefly, is the political market place?

A--The Structure of a Political Market


Legislative Branch
(Largely Majoritarian Decisionmaking Processes)
Executive Branch
(Largely Single Executive Decisionmaking In Hierarchial Structure
Judicial Branch
(Mixed Single Judge And Majoritarian Decisionmaking)

This chart is just to remind you of the basic structure of politics in American society. Ordinarily, the Judicial Branch is not thought to be a part of the political decisionmaking system; and, indeed, its judicial methods of decisionmaking are different from the political methods of the other two branches. Nevertheless, in the water field in recent years, it is clear that the Judicial Branch has an important role affecting decisionmaking within the Executive Branch.

B--The Political Actors in a Political Market

1. Legislative, Executive and Judicial Officers
2. Higher Civil Servants
3. Interest Groups - Leaders and Members
4. Influentials - Editors, Columnists, Lawyers, Well-Known Individuals, Etc.
5. Political Parties
6. Citizen-Voters.

This list is intended to be inclusive of all types of political actors. Lead planners and field decisionmakers should see themselves as "higher civil servants" in this list. "Interest groups" and "influentials", as well as interested individual "citizen-voters", are the ones who want to participate with lead planners and field decisionmakers in planning and decisionmaking. There is, of course, no practical reason for water and related land resource planning at all unless there is manifest public interest.

C--Multiplicity of Political Markets

1. Federal Government
2. Federal-State Institutions
   (e.g. Federal-State River Basin Commissions)
3. State Governments
4. Councils of Local Governments
5. Local Governments

There are many decision points relevant to water and related land resource plans. Lead planners need to identify and relate to the points of decision relevant to them in this whole complex of political markets.

D-Political Power in a Political Market

Political power can be said to derive:

Positively from: -- Leadership ability
-- Ability to persuade
-- Gamesmanship
-- Authority
-- Resources available for discretionary use

Negatively from: -- Ability to block or upset proposals of others through use of authority, resources, etc.

The meaning of this chart in terms of the exercise of effective political power in the sense of affecting "value allocation" could be discussed very extensively. Lead planners need to rely for their power largely upon their leadership ability and, in this connection, their ability to persuade. And their ability to persuade may well turn largely on their ability to relate clearly technical-professional considerations to public interests. Field decisionmakers have authority and thus a limited power. Interest groups and influentials possess no authority and they usually cannot ignore the authority of field decisionmakers. Nevertheless, they may be able to obtain a reversal of decision at a higher level of authority.

What is the "output of politics"?

> The output of politics is "policy" plus the value-significant results of its application by decisionmakers responsible for implementing "policy".

The final name of the game in the type of politics being discussed here is the achievement of "value-significant results" in actuality. But, to perform their key roles in achieving such results, lead planners and field decisionmakers must implement "policy".

What is "policy"?

> Policy is the criteria by which a decisionmaker decides what to do or what not to do in a given factual situation[3].

This definition, though very abstract, should be particularly meaningful to persons like lead planners and field decisionmakers who are in government. Persons in government are very conscious that criteria external to their own ideas constrain what and how they plan and make decisions on plans.

Moreover, from their perspective, lead planners and field decisionmakers can see that public policy relevant to them is a hierarchial system of constraints upon their freedom that is embodied in:

---

[3] Adapted from Carl J. Friedrich, "Constitutional Government and Democracy", (Ginn and Company, Boston, 1950) p. 362. Somewhat similarly, policy is defined by David Easton in "A Systems Analysis of Political Life", (John Wiley & Sons, Inc., New York, 1965) as "decision rules adopted by authorities as a guide to behavior . . ." (p. 358).

THE CONSTITUTION

LAWS AND LEGISLATIVE HISTORY

JUDICIAL INTERPRETATIONS

REGULATIONS AND EXECUTIVE ORDERS
(e.g. WRC's Principles and Standards)

"POLICY" STATEMENTS

PROFESSIONAL STANDARDS

PERSONAL VALUE PREFERENCES
↓
SPECIFIC DECISION → | ← SPECIFIC DECISION

All of these levels of public policy provide criteria that constrain plans. The higher levels constrain the lower-level sources of criteria.

Plans involving the taking of private land into public ownership are constrained by the U.S. Constitutional provision prohibiting the taking of land without just compensation. The U.S. Constitution also constrains planning by the Federal government due to the apparent fact that it has no authority to zone flood plains. Authority for flood plain zoning is only available to State and local governments. Also, the Federal government cannot directly assess specific lands for benefits received from flood protection storage. Thus, rather than wait for one or more benefited States to create the necessary local districts to provide reimbursement of some costs (as is the case with respect to Federal irrigation costs) the Federal government provides the larger flood protection storage works as a non-reimbursable Federal expenditure.

Policy embodied in law, the interpretation of which is conditioned by its legislative history, is extensive and becomes very particularized in application. Moreover, extant policy in law has been accumulated over a long period of time. Some, embodied in the common law, was established ages ago. Other extant policy was adopted by statute in the 19th century. Much more statute law still applicable to water and related land resources has been enacted in this century.

Judicial interpretation of law clearly provides decision criteria that planners cannot ignore. The well-known experiences of Federal water agencies since passage of the National Environmental Policy Act in 1969 make this evident[4/].

The extant Principles and Standards, regulations of the Water Resources Council, are clearly intended to provide criteria consistent with law to guide planners and decisionmakers.

The next three levels of criteria are very real, but less uniform and fixed, in terms of their effects upon planning and decisionmaking. Official "policy" statements are, in effect, calls upon lower officials in the exercise of their discretion to tilt their decisions in accord with the explicit or implicit criteria of the policy statement.

Professional standards derive from intellectual disciplines, training, experience, and professional-society policy. Engineers, economists, biologists, etc. all bring to their work the professional standards of their professions and they are expected to do so.

Finally, the value preferences of the planner or decisionmaker, within whatever freedom of decision is left to him, are inevitably involved in his decisions. His values, impacting upon his decisions, can be those that he has long held personally or professionally; or they can be values that he has decided to take into account as a result of public participation in processes of planning and decisionmaking.

Specific decisions can be said to derive (to continue the metaphor of hierarchy) from criteria imposed from above as well as criteria promoted by public participation from below. Because much that occurs in government depends upon the active interest and substantial concurrence of the affected publics, public participation is an essential element in the realization of plans in terms of actual operations and achievement of effects.

[4/] Frederick R. Anderson "NEPA in the Courts - A Legal Analysis of the National Environmental Quality Act", (Published for Resources for the Future, Inc. by The Johns Hopkins University Press, Baltimore, 1973).

Lead planners and field decisionmakers work at the initial interface in a specific factual context between government and what its policy permits, on the one hand, and specific public interests and what these interests need as the planner or they see their needs, on the other. This interface in such a context clearly puts lead planners and field decisionmakers in a political, that is, a value allocational role.

This conclusion leads directly to:

> Thesis #2: In his political capacity, a lead planner must relate to the publics interested in the alternative plans he is planning with a view to his obtaining, if possible, a viable coalition of support for a technically feasible plan.

"His obtaining", in the above statement, is meant to mean a leading activist role. To obtain a "viable coalition of support" for a technically feasible plan may require several iterations in technical planning processes in order for a lead planner to help build a coalition.

What is "coalition building"?

1. Polarization of Interests: Sometimes so, sometimes not.
2. Commonalities of Interests: Must be sought out.
3. Interdependency in Achieving Any Action: The threat of no action for anybody is a useful political force.
4. Compromise: Making political tradeoffs.

Interests may or may not be extremely polarized in opposite directions. In any case, plurality of interest usually means conflict of interest in some degree. The Principles and Standards call for presentation to the public of both optimum NED plans and optimum EQ plans. This may cause extreme political polarization; but, if it does, then probably such polarization was always latently there. The planner did not cause it. It will usually be necessary for him to deal with polarization by analysis of, and making known, potential tradeoffs between the extremes.

A positive role of the planner can be in identifying and making known common interests among opposing interests. For example, some recreationists have an interest in reservoir recreation, not all recreationists are wild and scenic river enthusiasts. But to obtain the support of reservoir recreationists, it may be necessary to decrease fluctuations of level and thus compromise, say, the full utility of a reservoir in providing hydroelectric peaking power.

Another positive role can be in letting the contending interests know that "nobody" is likely to get anything unless ways are found to compromise and build a viable coalition. Except in exceptional circumstances, decisionmakers at the higher levels of the Executive Branch and in the Legislative Branch will not allow themselves to become involved in wide-open complex controversies. In such circumstances, no decision is better than getting themselves involved in a situation through which they cannot hope to see their way.

What is a "viable coalition"?

1. Few interests, if any, are completely happy with a compromise plan.
2. Most people involved are happier with the compromise than without.
3. Continuing polarized interests cannot be effective in stopping plan.
4. Supporters of compromise are sufficiently supportive to obtain action.

If continuing polarized interests can stop a compromise plan, in the planner's judgment, then there is no point in proceeding with it. The planner, then or later, must reiterate the planning procedures and propose new technically feasible compromises that tradeoff pertinent values.

Even without active opposition, supporters of compromise plans must usually be clearly supportive to obtain action beyond the field level. If they are not sufficiently supportive, then there is no real point in investing much effort on the plan unless the supporters' minds can be changed to be more active.

What has been outlined here are only the bare bones involved in development of a viable coalition. In actuality, obtaining a viable coalition can be infinitely complex, involving many reiterative efforts, and the problem becomes even more complex, when decisionmaking moves from local, to State, to regional to national locations. Reiteration and changes in previous compromises, involving different publics in consideration of alternative plans, may become necessary.

Is all this really a new dimension in the role of lead planners?

> Thesis #3: The answer is no. Political participation in public decisionmaking is not really a new dimension in the role of lead planners.

But this lecture is not the occasion to prove that short answer in detail. Instead, it will be asserted that Colonel Pick of the Corps of Engineers and Glen Sloane of the Bureau of Reclamation must have exercised the type of political participation being discussed here when authorization was obtained of the 10 State Pick-Sloane plan for the development of the Missouri River Basin in the Flood Control Act of 1944.

Other examples from the past and present involving lead planners and field decisionmakers in political participation can be cited:

1. Obtaining a politically viable coalition: Main stem Columbia River developments.
2. Differential political power at different levels of decisionmaking: Colorado River Basin Project Act.
3. Public policy constraints--mostly fixed but sometimes can be made flexible: Recent Charles River, et al cases.
4. Political tradeoffs, the iterative process and much political participation to little avail: The Potomac River planning.

Finally, consideration needs to be given whether the Principles and Standards call upon planners to engage in the type of political activity that has been discussed here.

> Thesis #4: They do.

The Principles and Standards (pp. 102-103) stipulate four tests to be applied in formulating alternative plans:

(Political Test)

1. *Acceptability*--"Workability and viability of the plan in the sense of acceptance of the public and compatibility within known institutional constraints".

(Technical Professional Tests)

2. *Effectiveness*--Technical performance.
3. *Efficiency*--Least cost means.
4. *Completeness*--Capable of full realization.

The first test, acceptability, is clearly political, calling for political judgment.

The Principles and Standards imply, moreover, that lead planners need to be active political participants in order to apply them:

1. Vigorous efforts to obtain public participation in decisionmaking processes should be pursued (P&S p. 96).
2. The specification of the components "must reflect the specific effects desired by groups and individuals of the planning area" (P&S p. 97).
3. The specification of the components must reflect "specific components declared to be in the national interest by the Congress or by the Executive Branch through the Water Resources Council" (P&S p. 97).
4. "Conflict" as well as "complementarity" among components is recognized (P&S p. 97). Thus, conflict is not assumed to be generally resolved by economic analysis or market processes. Political means of handling conflict is implied.
5. "Reiteration" of the planning process is to be undertaken to aid in plan reformulation and ultimate selection of recommended plan (P&S p. 106).
6. Selection of a plan for recommendation must try to reconcile professional appraisal of beneficial and adverse effects in accord with specified decision rules *as well as* the "priorities and preferences expressed by the public at all levels to be affected by the plan" (P&S p. 107).

Thus, it would appear to be valid to say that the Principles and Standards, implicitly if not fully explicitly, call upon lead planners and field decisionmakers, not just to develop plans, but to be leaders on behalf of government to see that publicly acceptable plans are developed and brought to realization and to public use.

To recapitulate, four theses regarding involvement of lead planners in public decisionmaking processes have been set forth and supported in this lecture:

> Thesis #1: Lead planners must engage, not just in technical plan formulation and analysis, but also in political participation in public decisionmaking processes.
>
> Thesis #2: In his political capacity, a lead planner must relate to the publics interested in the alternative plans he is planning with a view to his obtaining, if possible, a viable coalition of support for a technically feasible plan.
>
> Thesis #3: Political participation in public decisionmaking processes is not really a new dimension in the role of lead planners.
>
> Thesis #4: The Principles and Standards, implicitly if not explicitly, urge lead planners and field decisionmakers to participate politically in public decisionmaking processes.

STEP 1-SPECIFICATION OF COMPONENTS OF NED AND EQ OBJECTIVES

Leonard T. Crook
Executive Director, Great Lakes Basin Commission
Ann Arbor, Michigan

The objective of presentation of Step One, is to reiterate and relate in a practical way the process of identifying problems and opportunities as the initial phase of plan formulation.

No attempt will be made to completely review the excellent Manual papers bearing upon this process, but will merely identify the highlights and indicate their application in relation to a real situation--the Bear Creek Basin in Utah.

For the purpose of review, let us look at the six steps of plan formulation again (Figure 1). Note that Step One provides for identification of the problems and specification of the component needs. A related Step, Five, provides for a revision of the components after alternative plans have been evaluated for tradeoffs. The difference between Step One in plan formulation for Level B and Level C studies is mainly in the detail used to identify the components.

Figure 1

1. Problems and Needs Components
2. Resource Capability
3. Alternative Plans
4. Trade Offs
5. Revised Components
6. Selection

It is desirable to have ready reference to the definitions of the words used repeatedly in this paper (Figure 2). Components are defined on Page 146 of the Principles and Standards. Components are specific, beneficial contributions to an objective in a particular planning setting.

Figure 2

Components	p. 146
Specific Components	p. 94
Component Needs	p. 94
Component Levels - NED	p. 94
First	
Second	

It appears to be fashionable, and sometimes even necessary, to select new words and define them for specific uses in developing a new technique such as advocated in the Principles and Standards. However, those with considerable experience in plan formulation will recognize that alternative names for component, or sub-objective, include measure, element, function, water resource purpose, or category. If these names reduce the mystery and promote greater acceptance, it is suggested that they be used concurrently with component, "component element", until the title component is part of your vocabulary. Specific components, component needs, and component levels--both first and second for all objectives--are defined on Page 94 of the Principles and Standards. Specific components are desired achievement of goals in terms of units of output. Component needs are the type, quantity, and quality of desired beneficial effects. There are at least two levels of components. The first relates directly to the output of goods and services to reach the objective. The second level of component relates to specific water resource needs to meet first level goods and services. These levels will be discussed further and examples given later on.

For added clarity, it may be well to differentiate between Level B and Level C studies. Briefly, these may be defined as follows:

> Level B are river basin or regional appraisal type studies of a reconnaisance level to resolve complex, long-range problems and present proposals to meet

middle-range (15 to 25 years) needs and desires. Level B's identify alternative plans and recommend actions and programs to meet middle-range needs (Figure 3).

Figure 3

Level B-River Basin or Regional Studies

1. Recon Level
2. Complex-Long Range
3. 15-25 Year Needs
4. Alternative Plans
5. Action Plans and Programs

Level C studies are those undertaken for implementation of specific projects or programs. They determine the project or program feasibility through estimates of cost, benefits and values. They are designed to carry out or reanalyze recommendations of Level A and Level B reports. In Level C studies, project or program authorizations are sought. These lead to more detailed designs and construction of projects (Figure 4).

Figure 4

Level C-Implementation Studies

1. Project or Program Implementation
2. Project or Program Feasibility
3. Carries Out Recommendations of Level A and B Reports
4. Seeks Project or Program Authorization

The first actions in Step One of Plan Formulation are to identify and list the full-range of both current and projected problems and needs. Then specific components are associated with these problems and needs. Reference is made to Pages 93-95 of Principles and Standards and to alternative plan components on Page 101 and the reconsideration of components as described on Page 105 (Figure 5).

Figure 5

Problems and Current Needs

1. Previous Reports
2. Planners
3. Public
4. Interaction

How are problems identified? Problems should be identified through a number of different processes. The include but are not limited to, (1) review of pertinent previous reports, (2) consultation with planners of Federal, State, regional and local governments to obtain their appraisals of the nature and severity of problems, (3) consultation and interaction with individuals from all types of associations and partisan public groups to assist in the determination of the needs, problems and intensity of feeling of the different users of the study being undertaken.

The planner would be well advised to restate in his own words, as best he can, those problems and needs identified by the reports, planners, and public; publish these and circulate them to all these individuals for confirmation; and after receipt of comments, modify statements regarding the problems for use as further guidance in the plan formulation process.

After problems and needs as currently understood have been identified, it is necessary to anticipate, or project, what the demand for water resources will be in the future over the long-range (Figure 6). Examination of the national baseline (or central case) projections, identified as OBERS, disaggregated to the area under study is an initial step. Comparison of OBERS national baseline projections, of one or more of the currently proposed series, with the projections made by the States and regional planning commissions for the area under study will give additional insight as to variations and the reasons for these variations in the planning areas. Projections are frequently made in the study process and, consequently, the projections utilized in previous studies and an examination of the experience subsequent to those studies will be useful and give additional perspective to the planner. It may be that no suitable projections appear to have been made for the areas and purposes intended. It will then be necessary to construct these projections during the course of the study. These should enable valid comparisons between alternatives based on different projections. Reference is made to Pages 96 and 97 of the Principles and Standards. The projections may cover a large variety of elements but should at the least measure future populations, employment, income, earnings, production, disposable income, and those other factors peculiar to the needs of the Basin. These projections are used to arrive at the units of output needs for the component specified.

Figure 6

Projections

1. OBERS
2. Alternative OBERS
3. States
4. Regional
5. Reports
6. Special
7. Derived Future Needs

Public participation (Figure 7) in the planning process should begin with initiation of plan formulation and carry throughout the planning effort. The excellent Manual papers on the subject of public participation will stand without amplification. However, it is desirable to mention for review purposes a number of the essential items to consider in deriving components. These are listed on the chart displayed. The public can assist in furnishing economic parameters useful to the planner. These economic and environmental parameters will vary with different publics. These publics may have conflicting views, and unless the various publics are contacted, a biased or skewed report will result. Public opinion is expressed in a number of different ways. Consequently, the more familiar the planner is with the people, opinions, literature, and area with which he is dealing, and the more immersed he becomes from contact with the public throughout his study, the more objective and unbiased he is able to be.

Figure 7

Participation

1. Economic Parameters
2. Publics
3. Public Opinion
4. Consideration
5. Meetings
6. Information
7. Planning Responses

It is essential that the planner indicate to the public that he is considering their opinions in his plan formulation activity. The planner frequently claims consideration of public opinion but does not overtly express that consideration and consequently, is frequently faulted by the public when he is attempting to present composite views. It is often necessary to indicate the wishes and desires of a particular segment of the public--even though they cannot be fully accommodated--the report should attempt to indicate the reasons therefore.

Meetings may be a useful device to obtain public opinion but there are numerous types of meetings. The planner desires freedom of expression by the public in a congenial or sympathetic atmosphere. This may not be possible, nor very productive. Meetings of all types can be devised to obtain needed information. However, all require advanced communication with the public and assistance to them in identifying the purposes of the meetings, the information desired, and sufficient time, opportunity, and convenience to permit deliberation by the public and the exchange of valid views.

Residents of an area have a wealth of information not recorded or available in written form. Their understanding of the potentialities of an area are also frequently very perceptive.

The planning process must be responsive to the public in a number of different ways. There must be adequate time for public appearances, reading of educational materials, and the development of confidence between the planners and the public. Planning materials should demonstrate the responses made by planners to the public. Information and education is a two-way street, and the planner should seek to learn as well as to inform.

Examples of National Economic Development (NED) components are identified on the chart (Figure 8) as first and second-level components. First level includes outputs to satisfy food and fiber, recreation energy, transportation, land, public services, and industry. Comparable second-level components for the same elements and outputs are measures of water and land for irrigation water and for recreation, hydroelectric power, navigation, flood free land, water supply for M & I (municipal and industrial), and water supply for industry. EQ components (Figure 9) include: (1) the general category of landscapes, (2) environmental habitat, (3) quality of water, land and air, (4) the elements of flexibility and reversibility, and (5) other components important to individual consciousness.

Figure 8
NED Components
(Outputs)

First Level	Second Level
1. Food and Fiber	1. Water & Land for Irrigation
2. Recreation	2. Water & Land for Recreation
3. Energy	3. Hydroelectric Power
4. Transportation	4. Navigation
5. Land	5. Flood Free
6. Public Services	6. Water Supply for M & I
7. Industry	7. Water Supply for Industry

Figure 9
EQ Components

1. Landscapes
2. Habitat
3. Water, Land, and Air Quality
4. Flexibility-Reversibility
5. Others

Although not proposed in this exercise, regional development components are broad factors relating to a particular region and include increases in income and employment, use of unemployed or underemployed resources, improvement of the regional economic base, improvement of regional, cultural, and environmental aspects, and improved population distribution. The Principles and Standards specified that formulation of plans to meet regional development will only be carried out when directed. The components developed for national economic development may serve regional development in that the same program measures may be employed with different degrees of intensity.

Planners should not confuse components of objectives with the accounting system required by the Principles and Standards. The accounting system identifies and attempts to measure beneficial and adverse effects of potential action programs. In the plan formulation process, the outputs of programs and project measures are related to the identified components.

The planner should be aware of preferences (Figure 10) that vary among components, agencies, by level of government, by the purposes of associations, and in several other ways. For example, there are certain elements or components within a region which have more value in meeting the various objectives than other components. While all components should receive consideration, that consideration will not, nor should it, be equal. An attempt should be made to explore more fully those components having the greatest values for meeting the objectives.

Figure 10

Preferences

1. Groups
2. Agencies
3. Congress
4. States
5. Regional
6. Local
7. Ranges
8. Components

Agencies with different missions will be prone to emphasize components stressing their mission. This is to be expected and should be accommodated to a reasonable degree. Congressmen have distinct bias' and reflect regional as well as national viewpoints. The committees of Congress desire programs and implementation projects achieving their own objectives. State programs frequently differ from regional programs and regional from local. These relate primarily to basic constitutional responsibilities and the degree and intensity of treatment. Attempts should be made to cover the full range of components and permit expression of the attitudes, needs, and positions of all these varying views. Associations having partisan interests in various types of components may be particularly useful but also difficult to handle. Components reflecting their views should be included and considered in relationship to the major objective.

The sensitivity of components should be examined methodically (Figure 11). This can be done by establishing alternative levels of components and of outputs. The responses needed in a planning context to meet these alternative levels of components should be tested thoroughly. The stability and durability of plans will be reflected in lack of sensitivity to changes in future levels of needs. The components should be adjusted to see what their effect is upon the plan and its costs. Like components can be grouped together and the number and range of alternative plans consequently reduced. Sensitivity analyses are an important adjunct of specification and testing of components.

Figure 11

Sensitivity

1. Alternative Levels of Components
2. Testing Responses Needed in Plans
3. Adjusting Components
4. Grouping Components

In summary, although Step One seems quite obvious, it is frequently inadequately developed. Specific actions are needed in order to consider the major elements identified in this process. The full range of components for all outputs to reach specified objectives should be sought. They should be intelligently grouped to minimize the number of alternative plans necessary to accommodate these components and also minimize the development of particular plan elements to meet certain components. The multi-purpose project still has validity if conscientiously sought and developed. Partnership with the public should be encouraged throughout the planning process.

The participants in the course are planners. They must recognize their role as planners and assist in the development of small group activities in an effective manner to achieve needed goals. This requires unit organization. Select a chairman and a reporter, cooperate with them. I suggest that you rotate leadership day-by-day in order to avoid role seeking. I also suggest that no one monopolize any phase of the activity but seek to coordinate and strive for production of maximum outputs.

STEP TWO (2) - EVALUATION OF RESOURCE CAPABILITIES

George H. Wallen
Environmental Specialist, Bureau of Reclamation, E & R Center
Denver, Colorado

The plan formulation process is a series of activities beginning with an authorization for a planning study and ending in a report recommending a plan of action. The six (6) steps in the plan formulation process are described on pages 90-197 of the Principles and Standards. This session covers step two of the plan formulation process which is identified in the Principles and Standards, page 90, as: "Evaluate resource capabilities and expected conditions without any plan."

Step two (2) is an important step in the plan formulation process. In this step, a majority of the background data necessary to plan formulation is gathered and analyzed. Component measures or plan elements that would meet needs or solve problems are uncovered and described. From this data base, alternative plans are formulated and beneficial and adverse effects are described. When this step is completed, all the work preceding an initial array of alternative plans should be accomplished.

The specific tasks to be accomplished during step two include:

a. A selective inventory of the resources of the planning area
b. An analysis of the capability of the existing resources to support future uses
c. The identification of measures or possibilities for management, development, and other opportunities for action to increase desired uses
d. The identification of planning constraints or problems that would inhibit the development of a plan of action

Selective Resource Inventory

The first task to be undertaken in step two (2) is a selective inventory of the resources within the study area. A resource inventory, as described in the Principles and Standards, does not differ substantially from previous studies. It is, by definition, ". . . a selective inventory of the quantity and characteristics of water and land resources of the planning area. . ."

It " . . . should include data on all physical factors appropriate to the investigation". In addition, information on biographical resources and social factors is needed in plan formulation and should be collected during the selective inventory.

The data that appear to be necessary for decisions on plan formulation in steps three (3), four (4), and six (6) should be assembled or collected. It is important, of course, to limit the effort to the collection of essential data. The information that is available in publications, drafts, or files should be examined first. The effort should focus on obtaining those pieces of data not already covered.

The level of detail of the inventory may vary with the type of study. Information to be used in a Level B study may not need to be as detailed as for a Level C study. A study of the reconnaissance, survey, or appraisal level may not be as detailed as a study at the feasibility level.

Another consideration in scoping the inventory is the problems and needs identified in step one. The inventory should focus on those resources that appear to be necessary to solve problems or meet needs. If water quality problems are identified in step one, a thorough analysis of the water quality in the study area may be necessary. If no water quality problems are identified, all that may be needed is a cursory survey to verify this situation. Where there are existing shortages of water that inhibit food and fiber production, a thorough analysis of lands to determine irrigation suitability would be warranted. Without evidence of need, previously published information on soil and cover types may be adequate.

With an eye toward the restraints on the inventory, some of the following topical areas may be included or at least considered for inclusion in a selective inventory.

Climate - Information on the climate of the study area should be assembled. It will have a bearing on any plans for increasing food and fiber production and recreational use. Rainfall amounts and patterns may be central to resolution of flood control and other problems.

Hydrology - As water planners, this may be the most important aspect. The inventory should cover all that is necessary to understand water-flows and timing of those flows throughout the planning area. The location and method of water storage is important as is the location and timing of diversions and depletions. Most agencies involved in water resource planning have been using hydrologic studies for years. With the standards more information will be needed on ground water; on the interrelationships with natural lakes; and on marshes, estuaries, and wetlands. The data requirements for ground-water resource evaluation and analytical and predictive methods utilized in ground-water investigations are described in Water Resource Council Bulletin 16, "Essentials of Ground-Water Hydrology Pertinent to Water-Resource Planning." Of course the information should be developed only to the detail necessary to solve problems and needs at the level of planning guiding the study.

Water quality - A general survey of water quality data, including dissolved oxygen, temperature, turbidity, and mineralization will be needed in all studies. The degree of detail and the amount of additional parameters to be covered should be keyed to the problems and needs of the area and the level of the study.

Geology, topography, and soils - These factors should be at least described but the effort need not include a treatise covering all of the planning setting. Some portions of the setting will have to be explored in detail while other portions may only be generally described. For example, the geology of the foundation material at a damsite may be critical to a decision while the geology of a nearby mountain range may be of interest. The topography and soils of an area to be served by water for irrigation are critical to plan formulation while this information for a wilderness area would be of limited use.

Land cover and use - Present land uses will give some clues to future capability. A description of the types of surface cover and the amount of each type is important. It is also important to understand ownership patterns (public or private). Ideally, the planning setting should be mapped showing land use suitability classes.

Environmental information - One area of the selective inventory that may not have been emphasized in past planning studies is environmental aspects. Environmental resources should be inventoried at a level comparable with other resources. The environmental resources important in plan formulation are described in the standards. Information related to each component may be important in formulation of plans and evaluation of alternatives.

Open space for human use and enjoyment may be a scarce commodity near urban and built-up areas. While the inventory of land cover and use will identify open areas, additional effort may be needed to describe those areas related to water that may have a bearing in plan formulation. These would be areas having potential for recreational use adjacent to streams, lakes and reservoirs, marshes, estuaries, and wetlands.

It may be important to inventory and quantify the reaches of flowing streams and acres of riparian lands to determine if protection of flowing steams is important in the formulation of alternative plans. If the planning setting includes streams listed for study under the National Wild and Scenic Rivers Act, a more detailed inventory would be required. However, streams not listed in accordance with the act may be suitable for some lesser degree of protection and this aspect should be studied during the selective inventory.

The preservation of lakes is a part of the environmental quality objective. An inventory of the number, location, and physical aspects of lakes occurring within the setting should be made.

An inventory of the beaches and shoreline areas along lakes and rivers in the planning area, as well as the coastline where appropriate, is necessary to insure consideration of outstanding beach areas in alternative plans. It will be important to inventory mountain and wilderness areas. It will be desirable to avoid locating water storage and conveyance facilities where they conflict with recognized wilderness preservation values.

Even though it may not be appropriate to publish a list of archeological resources located in a study area, planners will need to know where alternative plans affect them. Some consideration may be given to preservation and interpretation of archeological sites in water plans. Information on recognized historic sites should be collected from national, state, and local lists.

The selective inventory should cover endangered plant and animal species, and plant species or communities that are unusual, interesting, or otherwise considered important. Inventories of animal species might include big game, upland game, fur bearers, waterfowl, other birds and mammals, fish species, and invertebrates considered important to planning decisions. The inventory should focus on the habitat required to support desirable populations of animal species.

Those unique geological structures or formations that illustrate the development of the earth should be identified. A general description of the ecological systems occurring in the planning area should be included. Those features necessary to describe erosion rates, sedimentation rates, frail lands, and disturbed lands should be inventoried.

Other - other items that might be included in the selective inventory would be current and planned water uses. In addition, the inventory may cover those social factors necessary to make evaluations for the social well-being account. Items to be considered for this purpose include population characteristics, health characteristics, economic factors, crime and public safety, education, welfare, transportation, housing, recreation and health services, retirement facilities and programs, attitudes, opinions, and expectations.

Resource Use Capabilities

With an analysis of the information obtained through the inventory, it may be possible to predict the capability of the resources to support use. One way to approach this task is to start with purposes or uses that are made of water and related land. Evaluation of resource capability may cover the following uses:

Water for municipal, domestic, and industrial purposes
Environmental quality
Wild and scenic rivers - Wilderness areas
Fish and wildlife
Recreation
Water quality
Energy development (including materials)
Social factors and regional development
Production of food and fiber
Erosion, sedimentation, navigation, flood control
Supplies for management of public lands

Possibilities and Opportunities for Development and Management To Meet Regional or National Needs

Assuming that the existing resources will not provide for the magnitude of uses predicted in the area and to resolve existing problems and needs, the next task is to identify possibilities for management, development, and other opportunities for action. These may include:

Sites for storage and regulation of water supplies

Scenic stream preservation opportunities

Channel improvement possibilities

Possibilities for flood protection or control

Land treatment and enhancement possibilities

Possibilities for increasing food and fiber production

Preservation or enhancement of fish and wildlife and other living natural resources

Energy production possibilities

Other environmental protection and enhancement opportunities including public parks; natural lakes; beaches; wilderness areas; estuaries; wetlands; historic sites; archeological sites; and improvement of the quality of water, land, and air.

These possibilities and opportunities are the building blocks of the alternative plans. By proper selection of the development and management possibilities, plans may be formulated to meet the needs for each component of the objectives.

Future Without Conditions

A Federally sponsored water and related land development plan may be needed where non-Federal interests are not likely to utilize an area's resources in a manner compatible with the National interest. If the management possibilities and opportunities identified are likely to be implemented without Federal involvement or by separate agency action, a Federal plan may not be needed. The most desirable situation would be a plan developed by Federal, State, and local governmental agencies in partnership with private interests.

A scenario evaluating future without conditions should be prepared to guide the formulating of alternative plans. Future conditions, of course, should be studied from National, State, local and private interest viewpoints.

Plan Implementation Problems

The remaining task to be covered in Step Two is the identification of problems likely to present impediments to the attainment of the desired level of National or regional outputs of goods and services, environmental quality amenities, or social opportunities for the planning period. Problems may take the form of physical constraints that limit resource use, conflict in resource use, legislation that inhibits desired uses or development, or other limitations.

Summary

The display of alternatives, analysis of plans, and the selection of a recommended course of action will depend on the analyses made in Step Two of the plan formulation process. Careful inventories and analyses are necessary. If the five tasks described in the standards are accomplished during Step Two, the remaining planning efforts can be completed more effectively.

STEP 3 - DEVELOP ALTERNATIVE PLANS

Don Jones
Agricultural Economist
SCS, USDA, Washington, D.C.

The Principles and Standards outline a 6-step formulation process. They include as a step the decision to reiterate after the fourth step when necessary. In the first step, component needs are specified and problems are identified. Step 2, the resource availability of the watershed or basin with which we are working is enumerated through inventories relevant to the component needs as specified in the previous step. The third step, alternative plans to meet the component needs are formulated. These plans will be tested for acceptance, completeness, effectiveness, and efficiency. In the fourth step, we analyze and compare these alternative plans. If at this point in the planning process when the plans are found to be lacking in their satisfaction of the expressed component needs, we can decide to repeat this four step process. If we are satisfied with what we have - actually the fifth step - we will go on to the sixth step, the selection of a recommended plan.

In formulating alternative plans, the presence of a situation where there are few or no constraints or where the components of the objective are essentially complementary, we could need only a single plan. This plan would meet the component needs that were expressed. This would be possible in a situation where no resource constraints existed.

While this is possible, this may be a very unlikely situation. A more representative situation would be one in which there were conflicts for the use of the resources. That is, instead of the component needs being complementary, satisfaction of one would reduce satisfaction of the other. Frequently, competition between satisfaction of the various needs results from constraints or limitations on the resources available to meet these needs. Another reason for formulating alternative plans would be where uncertainty with respect to the future economic conditions exist. Also, where uncertainty exists with respect to future preferences. Other factors contributing to the necessity to formulate alternative plans include planning and administrative constraints.

Where there does not exist a strong linkage between water and land development, the Water Resource Council's baseline projections can serve as a single set of projections for the future level of economic activity of the area. However, where a strong linkage does exist between water development or land development and economic activity, it may be necessary to formulate an alternative set of plans to reflect the various development opportunities within the project area. Sensitivity analysis can be used to examine the extent to which component needs will vary under different assumptions concerning the future.

To begin the task of formulating alternative plans, it will be necessary to know whether measures or project features contribute specific or multiple outputs. For example, a multiple output could be a retarding structure used to store water for irrigation to provide flat water recreation during part of the year; may release stored water for downstream irrigation diversion; and could also enhance a stream fishery within certain river reaches. Pump irrigation, on the other hand, serves only the irrigation need. While each of these measures will meet the component need for increased agricultural output, they do so at different costs and with different incidental effects on other economic and environmental needs. The significance of this is that it provides (1) effective alternative means to satisfy needs, (2) information on complementary or conflicts, and (3) a basis for selecting alternative means of satisfying varying levels of the components needs. This information will then become the building blocks for plan formulation.

The number of alternative plans that can be formulated, probably can not be specified in advance. The "Principles" state that, "One alternative plan will be formulated in which optimum contributions are made to the national economic development objective. Additionally, during the planning process, at least one alternative plan will be formulated which emphasizes the contributions to the environmental quality objective. Other alternative plans reflecting significant physical, technological, legal or public policy constraints or reflecting significant trade-offs between the national economic development and environmental quality objective may be formulated so as not to overlook the best overall plan" (Page 15, P&S). The statement in the "Standards", however, differs from that in the "Principles" in one respect. That is, the words "constraints", "physical", "technological", "legal", or "public policy constraints" are not referred to in the "Standards". The "Standards" merely state that, "Other alternative plans reflecting significant trade-offs between the national economic development and environmental quality objectives may be formulated so as not to overlook a best overall plan" (Page 102, P&S). It would appear that the difference in these two documents could be significant if the constraints are placed on the formulation of a plan which emphasizes environment, or a plan which optimizes economic development. It would be or should be, at least, a very different plan from one that is not constrained. For example, if we constrain a plan by considering no retarding site over 5,000 acre-feet, we may rule out the most feasible alternate plan from an economic point of view, possibly even from an environmental point of view.

Once the alternative plans have been formulated, we are instructed by the "Standards" to apply four tests to each of these plans as follows: (1) Acceptability - is it a viable and workable plan?; (2) Effectiveness - does it meet the component needs we started out to achieve?; (3) Efficiency - is it the least costly, structural or nonstructural, private or federal means of achieving the outputs of the plan?; and (4) Completeness - have we accounted for not only the installation but also the maintenance, operation, replacement of those items that will wear out to assure that the plan will function during the evaluation period?

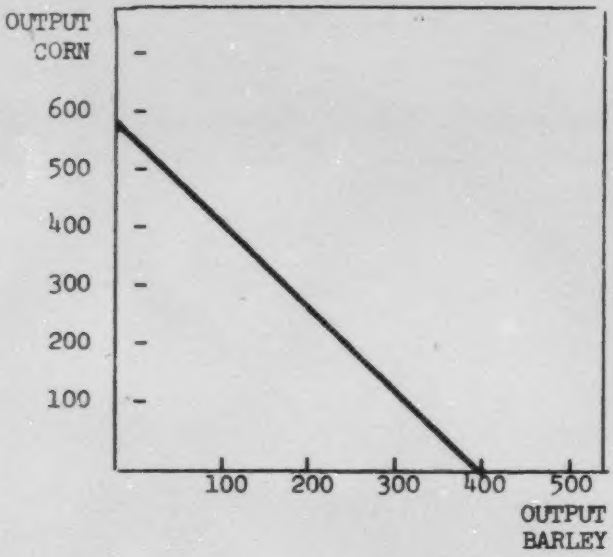
One other possible plan can exist. The "Standards" refer to this as a no development plan. It does not refer to the "without" condition. It does specify, however, that a no development plan must have positive actions to assure that the lack of development or the maintenance of the status quo is achieved through positive actions such as land acquisitions and zoning.

Early in this presentation, complementary and competitive relationships were discussed. The following tables and graphs display the production possibilities that exist through use of a specified "bundle" of resources. That is, for each output or combination of output, the underlying assumption is a constant quantity of factor inputs - capital, labor, land and management. Consequently, the cost level for each output combination is identical. Table 1 and Figure 1 display the outputs of corn and/or barley which can be achieved with a specific resource bundle.

Table 1: Production possibilities for corn and barley through alternate uses of resources.

Rotations		Yield		Output	
		Corn	Barley	Corn	Barley
8 Corn		70		560	
7 Corn	1 Barley	70	50	490	50
6 Corn	2 Barley	70	50	420	100
5 Corn	3 Barley	70	50	350	150
4 Corn	4 Barley	70	50	280	200
3 Corn	5 Barley	70	50	210	250
2 Corn	6 Barley	70	50	140	300
1 Corn	7 Barley	70	50	70	350
	8 Barley		50	0	400

Graphically, the information in Table 1 above appears in Figure 1 shown below.



Each of the nine possibilities in Table 1 is an alternate plan for the use of these resources. Assuming our decision criteria is to maximize gross return from this resource bundle, the optimum use of the resources can be ascertained by determining the price or value of each product and calculating gross revenue. If the market price for both corn and barley is $1 per bushel, the gross revenue would range from $560 if only corn is produced, to $400 if barley is produced. Table 2 below has assumed three different price relationships for corn and barley to show what can happen in the selection of an optimum condition when a purely competitive condition is encountered.

Table 2: Gross revenue for alternative use of resources under varying product price relationships and optimum plan when gross revenue is the decision criteria.

Output		Gross Revenue ($) When:		
Corn (Bushel)	Barley (Bushel)	Corn - $1 Barley - $1	Corn - $1 Barley - $2	Corn - $1 Barley - $1.40
560	0	$560	$560	$560
490	50	540	590	560
420	100	520	620	560
350	150	500	650	560
280	200	480	680	560
210	250	460	710	560
140	300	440	740	560
70	350	420	770	560
0	400	400	800	560

Notice in Table 2 that the optimum will be either all corn or all barley unless a very special price relationship exists; that is - where the ratio of price of corn to the price of barley equals the ratio (sign omitted) of the change in barley output to change in corn output[1], at which time any alternative is optimum.

An example of purely competitive case in the water resource field is the pothole area of the north central U.S. The use options, alternative plans, for these potholes are wheat production if drained or duck production if preserved. Whether these potholes are drained or preserved should depend on the relative value that society places on additional food output or on additional ducks.

In the following example, again taken from agriculture, increases in the output of one produce results in an increase in the output of the other. Table 3 shows the combined outputs of corn and hay that can be achieved.

Table 3: Production possibilities for corn and hary through alternate uses of resources.

Rotations		Yields		Output	
		Corn	Hay	Corn	Hay
8 Hay			3.0		24.0
7 Hay	1 Corn	90	3.6	90	25.2
6 Hay	2 Corn	110	4.0	220	24.0
5 Hay	3 Corn	100	4.0	300	20.0
4 Hay	4 Corn	90	3.6	360	14.4
3 Hay	5 Corn	80	3.2	400	9.6
2 Hay	6 Corn	70	3.2	420	6.4
1 Hay	7 Corn	60	2.0	420	2.0
0 Hay	8 Corn	50		400	0

---

[1] \$1.40 ÷ \$1 = (560-490) ÷ (0 - 50)
1.40 = 70 - 50
1.40 = -1.40

Graphically, the information in Table 3 appears as shown in Figure 2.

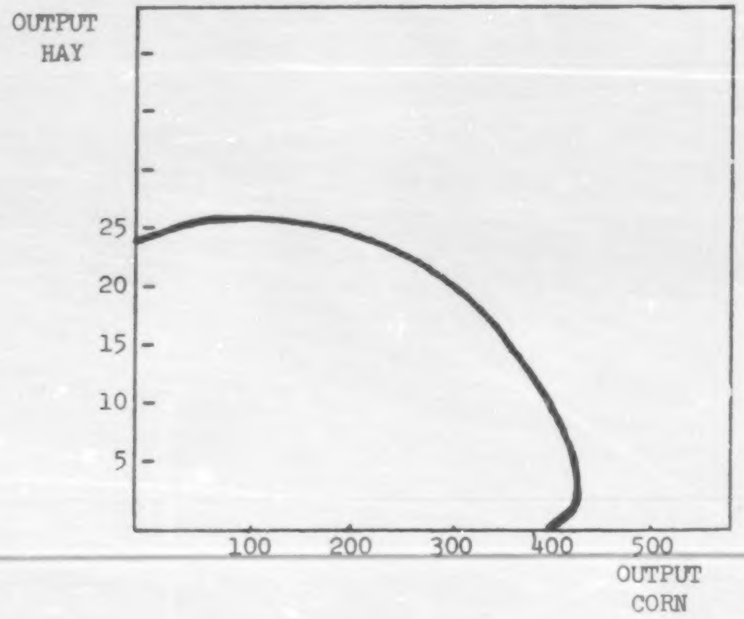


Figure 2. Production possibilities for corn and hay through alternate use of resources.

Table 4: Gross revenue for alternative use of resource under various product price relationships and the optimum plan when gross revenue is the decision criteria.

Output		Gross Revenue When:		
Corn (Bushel)	Hay (Ton)	Hay $20 Ton Corn $1 Bu.	Hay $20 Ton Corn $2 Bu.	Hay $20 Ton Corn $1.50 Bu.
0	24.0	$480	$480	$480
90	25.2	594	684	639
220	24.0	700	920	810
300	20.0	700	1000	850
360	14.4	648	1008	828
400	9.6	592	992	792
420	6.4	548	968	758
420	2.0	460	880	670
400	0	420	800	600

One area of complementary in this example is in the first two lines of Table 3, whereby producing 90 bushels of corn an increase is also achieved in the production of hay. The other area is the last three lines of the table, where an increase of resources used for corn results in only maintaining or lowering corn output while, at the same time, reducing the output of hay. The remainder of the information in Table 3 delineates the competitive production alternatives between hay and corn; that is, increases in the output of corn is possible only by reducing the output of hay.

Again, note in Table 4, that as the price relationships change, the combination of crops that produces the maximum gross return - optimum point - also changes. Thus, the optimum point is the point at which these crops are competing with each other for the resources.

This type of situation probably exists more frequently in water resource developments than the purely competitive case demonstrated earlier. In either case, the optimum solution will be where the different outputs are competing for the resources and will be determined by the relative price or value of these commodities.

Where water resources have potential to produce different products, the combination that society chooses to have produced should reflect their relative preference for these outputs. While the selection of the recommended plan is Step 6 of the planning process, it is in this step - Step 3 - Formulation of Alternative Plan, that the types of relationships which can exist between the different outputs can assist in assuring that the significant alternative plans are formulated.

STEPS 4 AND 5-COMPARISON OF ALTERNATIVE PLANS

Don Jones
Agricultural Economist
SCS, USDA, Washington, D.C.

The fourth step of the plan formulation process, detailed in the Standards, analyzes and compares the plans formulated in Step 3. As a result of this examination, a determination must be made (Step 5) to either reiterate the planning process or to go on to Step 6 - Selection of a Recommended Plan.

This analysis and comparison is to: (1) determine the effectiveness of the alternative plans in meeting the component needs of the objectives; (2) determine the differences in the alternative plans in terms of their contribution to the objectives and where appropriate to the Social Well-Being and Regional Development account, and (3) determine the relative value of the beneficial and adverse effects that are essentially presented in nonmonetary terms. This last determination will be made by expressing the national economic development benefits foregone and/or the added monetary costs incurred to achieve the plan effects.

The first determination will involve analyzing how well the plan achieves the component need that served as a basis for its formulation. Since there will be competition for resources to produce the various component needs within the economic development objective as well as between this objective and the environmental quality objective the relative value of the various outputs should determine the desired product mix within alternative plans.

The second determination will require summary or comparison of each plan with all other alternative plans. These summaries can efficiently be presented by use of comparison tables to display the differences between each pair of alternative plans. That is, Plan A will be compared to Plan B and Plan B to Plan C as well as Plan A to Plan C. With a large number of alternative plans, these comparison displays will become quite numerous.

The third determination, monetary equivalent of nonmonetary effects, should be discernible from the display comparisons from the preceding effort. Those environmental outputs which are complementary with economic development output will not have tradeoff effects.

While the Principles and Standards state that the inclusion of the EQ account eliminates the need to determine and show proxy values for the environment, the fact remains that administrators and decision makers still, more readily, relate to monetary and proxy values.

If, on the basis of this analysis, the determination is made to go to Step 6 - Plan Selection - the material developed during this step will be of value to those who must select from among the alternative plans.

STEP 6-SELECTION OF A RECOMMENDED PLAN

Emil W. Adam
Chief, Plan Formulation Branch
South Pacific Division, Corps of Engineers
San Francisco, California

The Principles and Standards state "The culmination of the plan formulation process is the selection of a recommended plan from among the alternative plans. Based upon the analysis of alternative plans and the results of reiterations of the plan formulation process, a set of alternative plans should be developed--each one of with (sic) given the relevant mix of contributions to components of the objectives, could be selected on its own merits as a recommended plan or recommended course of action. It is from among these alternatives that a recommended plan will be selected." (p. 106, Principles and Standards) Selection of the plan to be recommended and its presentation in the report and presentation of the basis for selecting the plan to be recommended is extremely important in the very visual or fish bowl planning that we do today. Let's think about that. If we only knew enough to integrate all the inputs into a study giving each one its true weight, it would be possible to select a plan that would: first, do more good than bad; second, do the most good and the least harm; third, describe the selection in such a way that most people would see the basis for that choice and could not logically provide substantial arguments against it. Recall that I said, "If we knew enough" - we could do all that. The point is that we are here because we don't know all the answers but we are going to try and develop ways to select and present a plan that will: (a) do more good than bad through selection of the correct economic and environmental benefits minimizing both the economic cost and the adverse effects to the environment; (b) reflect general agreement of the affected public, and (c) be in the Federal interest. The Principles and Standards have provided guidance on how these may be accomplished and we are exploring ways of implementing that guidance.

Three of the subjects that I consider especially important in selecting the recommended plan are:

1. Compromise solutions
2. Public participation and
3. The public decision making process

A planner must also be aware of the compromise that is necessary by the various publics to arrive at a consensus for a single plan. So, in addition to the other skills a planner must develop, that of an arbitrator is becoming increasingly important. Training to develop this skill should be a part of the career development program for people involved in plan formulation and selecting the plan to be recommended.

Obtaining inputs from the public during plan formulation and selection of a plan is also very important and difficult to achieve. It is better to be aware of all the problems prior to selection of a plan than hear of them in the form of opposition to the plan after it has been selected. It is too often assumed that public input will be automatic at public hearings and other such forums held during the study. Many times the study goes along seemingly without any diverse public preferences expressed until announcement of the selected plan. At that time, it is almost too late for compromise. Positions have become polarized and for the lack of obtaining adequate public input prior to selection of the plan a potentially good project could become stalemated. The skill needed to obtain adequate public input must be developed. It is less costly to educate planners by sending them to training courses and seminars than having them learn in the school of hard knocks, which is painful to both the employee and the agency, and more costly to the nation. Rescheduling reports, fighting law suits, abandoning partially completed projects are all very costly to the nation and are often the result of not obtaining adequate input from all the Publics prior to selecting the plan. I want to emphasize the plural--Publics. A broad cross section of affected people should be heard from, not just elected officials and sponsoring organizations. Those in opposition should also have an input.

The first week's lectures and discussions on measurement of effects on National Economic Development and Environmental Quality and the impacts on Regional Development and Social Well-Being are important not only in selecting a plan but also in presenting it, by comparing it with other alternatives and explaining the basis for the selection. As is discussed later, a set of tables has been developed for the purpose of displaying these comparisons, samples of which are given in the Principles and Standards beginning on page 126.

In selecting the plan, a brief overview may be helpful. One of the first steps to take is to acquire a feel for the physical, economic, cultural and environmental characteristics of the basin and what the basin could accomplish without additional development of the water and related land resources, including generally the potential for development of these resources and how much is needed. A review of these needs and opportunities for water resource development will assist you in the final selection of an appropriate plan. However, there is more to consider.

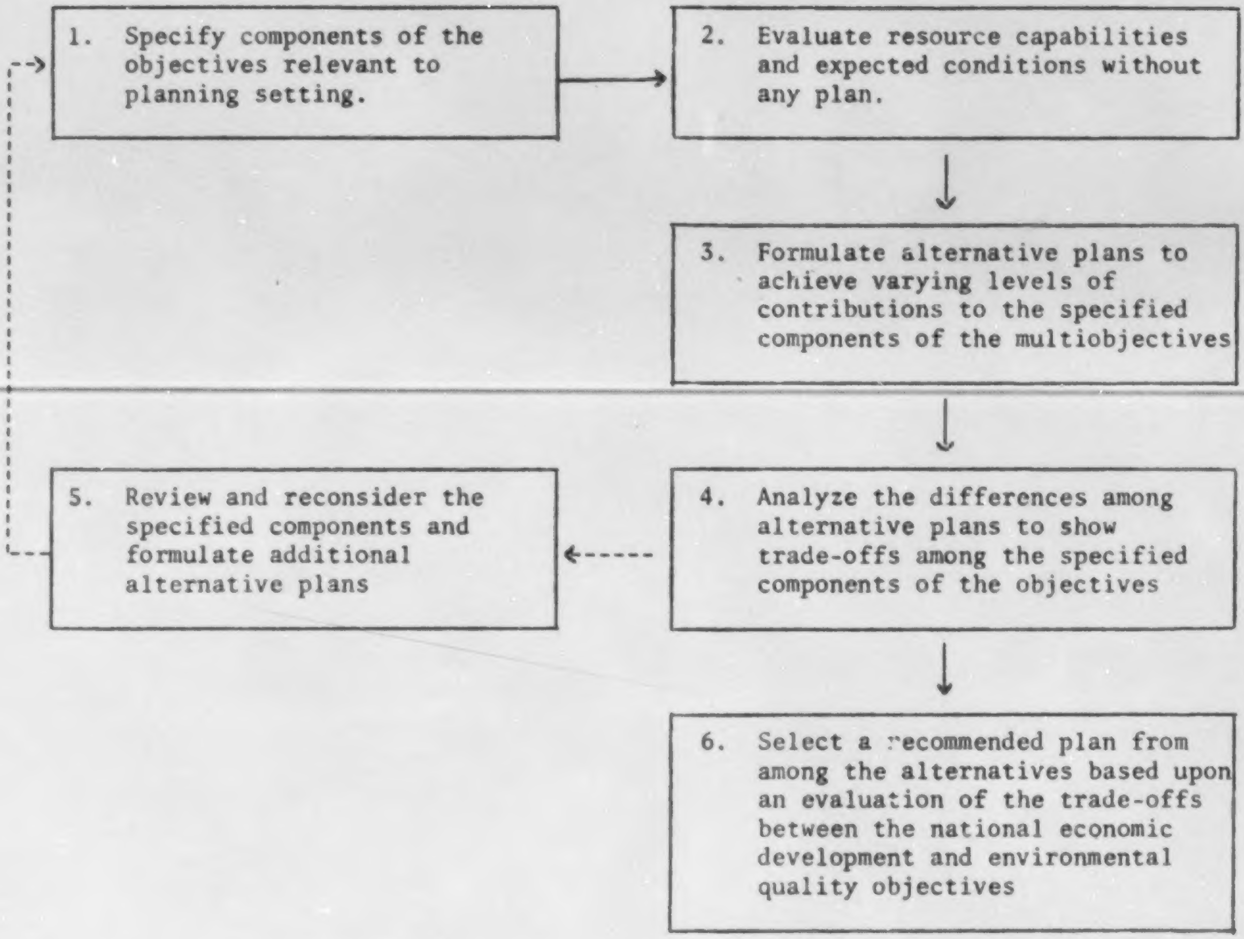
In any worthy plan, it is essential to select and list the components of both national economic development and environmental quality objectives applicable to the needs and opportunities of a study area. The publics opinion, for and against certain types of development, must be carefully assessed. Using these inputs, including related needs, opportunities and views of various publics, makes it easier to identify applicable components of the objectives. These components then form the basis for decisions regarding water resource development as land treatment, irrigation and drainage, recreation, fish and wildlife, preservation and enhancement of the environment, flood control, wastewater management, streambank and shoreline erosion, water quality, municipal and industrial and rural water supply. Plan selection actually involves formulating several alternative structural and non-structural plans, one which emphasized national economic development and one which emphasized environmental quality and several other plans in between these two extremes.

These require prepared statements of dollar benefit and other positive impact determinations including prepared statements of costs and other negative impact determinations. In order to better describe each plan and to facilitate comparisons, it is essential to prepare tables showing impacts of each plan for each of the two objectives NED and EQ under the four accounts, NED-EQ-RD-SWB.

The accomplishments of the above formulation steps are very pertinent to a selection of a recommended plan as well as to set the stage for the actual selection process. Selection should begin with a review of the measures of effects for each of the alternative plans. An inspection related to the previous formulation steps should effectively screen the number and types of alternatives that are to be considered as candidates for a recommended plan. In general, these alternatives should possess the following characteristics: (1) For the given set of component needs, each alternative plan should be the most efficient means to achieve those needs. (2) The plans should be significantly differentiated from each other, primarily in terms of emphasis on objectives; that is, each alternative plan makes a unique contribution to one or both objectives not provided for by any of the other alternatives under consideration. Using the analysis of alternatives, those alternatives that may have been formulated with essentially similar characteristics in terms of component needs with only minor differences should be screened to select the alternative that provides the best mix of contributions to the specific set of component needs. (3) Without regard to assigning priorities or weights to the component needs of a particular alternative to differentiate such alternative in terms of the other alternatives, each alternative must be "justified" in the sense that in the judgment of the planning organization the total beneficial effects (monetary and nonmonetary) to the objectives relevant to the alternative are equal to or exceed the total adverse effects (monetary and non-monetary) to those objectives.

Figure 1 shows a screening process for selecting a recommended plan from among the remaining alternatives. It is essentially a choice governed by a reasonable and rational perception of priorities and preferences about the mix of objectives. It is not a choice predicated upon an analysis of the most justified plan, since each alternative to be considered at this step of the overall formulation process can be justified on its own merits in terms of its contributions to the given mix of component needs relevant to each alternative.

Figure 1


1. Specify components of the objectives relevant to planning setting.
2. Evaluate resource capabilities and expected conditions without any plan.
3. Formulate alternative plans to achieve varying levels of contributions to the specified components of the multiobjectives
4. Analyze the differences among alternative plans to show trade-offs among the specified components of the objectives
5. Review and reconsider the specified components and formulate additional alternative plans
6. Select a recommended plan from among the alternatives based upon an evaluation of the trade-offs between the national economic development and environmental quality objectives

The selection process is one of repetitive comparison, analysis and evaluation. The four account impacts for each alternative plan must be constantly reviewed and analyzed as must the input from the publics. In this connection, the necessity of soliciting additional information on public reaction to the various alternative plans should be constantly assessed.

Plan selection must also consider constraints by:

1. Federal law
2. Federal policy
3. State law
4. State policy
5. Regional compacts
6. Other constraints may be applicable.

The plan selected may recommend modification of existing law, policy or other constraints when it is demonstrated that such a change would be beneficial and implementable.

Finally, a review of the effectiveness, efficiency, and completeness of each of the plans including further consideration of a "no development alternative" would provide additional basis for plan selection.

Plan Selection

The Principles and Standards state on page 16, "...From its analysis of alternative plans, the planning organization will select a recommended plan. The plan selected will reflect the relative importance attached to different objectives and the extent to which the two objectives can be achieved by carrying out the plan."

That is a simplistic statement because in the real world of seeking acceptance of a plan, a consensus of the various Publics is required. How consensus is achieved to the extent necessary to allow implementation of the plan is the problem.

This discussion on plan selection is a mix of concepts borrowed from various sources, some generally accepted and some controversial. The plan selection process described in the Principles and Standards simply incorporates the data required to formulate and analyze the alternative plans into existing selection processes. If explicit priorities or weights were assigned to the beneficial and adverse effects to each component need of the objectives, it would be possible to select a best plan to be recommended with a minimum of judgment. In most cases, however, such priorities or weights will not be available and, as set forth in the Principles, selection of a recommended plan will be based upon an appraisal so that the beneficial and adverse effects to the mix of objectives, to the best of current understanding and knowledge, reflect the priorities and preferences expressed by the public at all levels to be affected by the plan. The selection process itself is different for each of the three levels of planning. The greatest difference between them is the amount of public participation involved in the actual decision.

Level A and Level B studies solicit and obtain public input during the study period but generally, the plan is formulated and selected by the interagency group. It is then presented to the public for approval or comment. The selection process for these plans involving large areas is too complex for much public involvement.

The use of alternative futures based on a range of projections combined with emphasizing several objectives for several subareas can result in almost an infinite number of combinations. It is crucial to the decision making process that the alternatives considered be reduced to a manageable number. In this connection selection process is closely tied with the formulation of alternative plans. Several alternative plans for subareas or planning areas must be developed and then grouped, tabulated, displayed, arranged, summarized or otherwise organized to provide the basis for large area wide alternative plans. The alternative plans can be arranged with NED plan and the EQ plan as the two extremes with various combinations of trade-offs arrayed in some order in between. Arriving at the NED and EQ plans is relatively easy since they by definition are formulated for only one objective without any trade-offs. Limiting the other possible combinations is necessary and difficult. One method of selecting a plan for a large area is to first select the best plan for each of the smaller planning areas. Each area is analyzed, and based on the experienced judgment of the multi-agency-interdisciplinary team, a plan or several plans are selected.

The resulting alternative plans should be tested to determine consistencies of data such as hydrology and other engineering and economic considerations to assure viability when the small area plans are integrated. Adjust plans if necessary to assure that projects and programs are compatible from a systems operation standpoint. This may necessitate reiterations of the planning process for some of the plans.

In some areas where there is no competition for the resources and therefore no controversy, there may be only one objective emphasized in development of plans. The choice to be made in this case is to select the alternative that best meets this objective. In other areas there may be competition for the resources that will require alternatives for more than one objective. This will require that a reasoned choice be made to select the alternative that makes the best contribution to the objectives. Perhaps the process would be facilitated if areas of low controversy were considered first and a plan nucleus selected. For example, in a particular small area, a single noncompetitive plan maximizing either NED or EQ might be included in all alternatives being formulated for the large area. That small area would then be the nucleus on which to build.

Where there are controversies, the greatest emphasis on the small area alternatives should be placed on the objective selected to govern the direction in which the overall larger plan would be maximized.

The plan selection process for Level C is quite different. A variety of methods are used by the various Federal agencies and even vary somewhat between regions within the same agency. It is not the intent here to describe the right way, if one has been developed, but rather to discuss and encourage an interchange of information with a view toward improving existing procedures. The role of public participation becomes increasingly important as the time begins to shorten when a plan is about to be implemented. Selection of a Level C implementation plan is something definite to which the public can react. Public participation in the actual selection of the plan has been found to be troublesome, exasperating, time- and money consuming, but extremely necessary. The reason why it has all those disagreeable qualities is because we have not learned how to get the public involved constructively. The concept of the public being involved in plan selection is very young and in the first stages of the evolution necessary for development of a mature process. Involving the public at this stage is being accomplished in many ways; I will describe briefly what the Corps of Engineers, South Pacific Division, is doing--not to say that this is the best way, but it is one way. I also want to make clear that this is not a Corps-wide process.

First I wish to emphasize that significant public input is received during the formulation of the various alternative plans so that the array of plans from which the recommended plan will be selected will include all those that have support of any significant public. I should say we try to include all those that have significant support. We then hold a public meeting with everyone invited who has shown an interest in the study, as well as those whom we think would or should be interested in the possible implementation of any of the plans. A brochure is prepared describing each of the alternative plans. The information on each plan is explained in lay terms so that it can be comprehended by a fairly well informed person. It is also of sufficient detail to give such a person information on all of the significant impacts and implications suggested by each plan. In other words, if the size of a bridge member is going to be determined by public vote, be certain the voters are well informed of the consequences of choosing a small section. The brochure is mailed with the announcement of the meeting; it is available at the meeting; and then each plan is described during the meeting. The meeting announcement states that its purpose is for selection of the plan to be recommended for authorization. For local protection projects, it is essential to have a sponsor; i.e., a local entity capable and willing to assume the required items of local cooperation. Such entities are more attuned generally to local public desires than are Federal officials, so following a public meeting, the sponsor is asked to indicate which plan should be recommended for construction. If all steps of the plan formulation have been properly taken, the final selection of the most preferable plan should come as no surprise.

In the case where a large multiple-purpose development is under consideration for authorization, an advisory committee should be organized with representation from national, state and local governmental and private organizations. The selection process would then move toward the process described under Level B study.

In a training exercise after selection of a plan, there is provision for reaction by the publics. Anticipating public reaction will sharpen one's senses and will probably result in a better end product.

Presentation of the Plan

The Standards state: "An explicit presentation will be shown of the comparisons and resulting trade-offs of the recommended plan to other alternative plans considered for recommendation. This will be shown in accordance with the system of accounts in Section VI" (page 107, P&S).

The basis of selection will be fully reported upon indicating all considerations made in the selection process. A recommended plan must have net national economic development benefits unless the deficiency in net benefits for that objective is the result of benefits foregone or additional costs incurred to serve the environmental quality objective. In such cases, a plan with a less than unity benefit-cost balance may be recommended as long as the net deficit does not exceed the benefits foregone and the additional costs incurred for the environmental quality objective. A Departmental Secretary or head of an independent agency may make an exception to the net benefits rule if he determines that circumstances unique to the plan formulation process warrant such exception.

Tables 1 through 5 (pages 111-125, P&S) developed in previous steps in the plan formulation process indicate the appropriate displays of beneficial and adverse effects of each plan in the four accounts. Let us now consider a second series of displays (Table 6) which will be used to provide a comparison of alternative plans. Each of the alternative plans will be paired with the recommended plan so that the advantages and disadvantages of each can be compared. The information needed for this second series of displays will be taken from the first series (Tables 1 through 5). The information should be summarized and condensed to make it as brief and yet as meaningful as possible. Differences between the recommended plan and alternatives should be set forth in a consistent manner so that positive and negative differences in beneficial and adverse effects are readily discernible. Table 6, Figure 2, illustrates the nature and content of this series of displays. This Table is copied with slight modifications from the Principles and Standards,

Figure 2

Table 6 Summary Comparison of Two Alternative Plans
(Use Additional Table for Each Relevant Comparison)

Account	Plan B	Recommended Plan	Differences (recommended plan minus Plan B)
National Economic Development:			
Beneficial effects-	$5,000,000	$8,000,000	+$3,000,000
Adverse effects----	5,000,000	6,000,000	+ 1,000,000
Net beneficial effects----	0	2,000,000	+ 2,000,000
Environmental Quality: (Use same component stubs for beneficial and adverse effects as illustrated in Table 3. Examples follow.)			
Beneficial and adverse effects:			
A. Open and green space, lakes, wild and scenic rivers, beaches, shores, mountains and wilderness areas, estuaries and other areas of natural beauty.	A. Create lake with 3,000 surface acres, 60 miles of shoreline and depth of 70 ft with high quality water and excellent access.	A. Create lake with 3,500 surface acres, 70 miles of shoreline and depth of 80 ft with high quality water and excellent access.	A. Create larger lake by 500 surface acres, 10 miles of shoreline and 10 ft of depth. Either plan would have high quality water and excellent access.
		Inundate 3,500 acres of open and green space, 10 miles long and 1/2 mile wide, located along stream and near city.	Inundate 3,500 acres of open and green space, 10 miles long and 1/2 mile wide, located along stream and near city.
B. Archaeological, historical, biological, and geological resources and selected ecological systems.	B. Inundate recognized historical archaeological feature.	--------------	B. Do not inundate recognized historical archaeological feature.
C. The quality of water, land, and air resources.			
D. Irreversible commitments of resources to future use.			

page 126 to 139. The table headings indicate columns first for "Account" the second for one of the alternative plans. In this instance, the second column is labeled "Plan B," the third column is the "Recommended Plan" and the last column is for the "Difference (Recommended Plan Minus Plan B)."

The first item shown under account is National Economic Development with beneficial effects, adverse effects shown as dollar amounts under both Plan B, and the recommended plan. The amounts are obtained from Table 2. The Difference Column is computed as it states "recommended plan minus plan B." The last line is "Net beneficial effects" which is the difference between beneficial and adverse effects. The next item under Accounts is Environmental Quality, with the four component categories of beneficial and adverse effect. The first component is "A", open and green space, wild and scenic rivers, lakes, beaches, shores, mountains and wilderness areas, esturaries and other areas of national beauty. The beneficial and adverse effects for this component are listed under Plan B and the recommended plan. They are nonmonetary descriptive impacts obtained from Table 3. The "Difference" Column is obtained as before by subtracting the recommended plan from Plan B. All of the impacts listed in Table 3 should be included on Table 6 under the appropriate account and column. If all the comparisons are not shown a bias will be built into Table 6. In this respect, it should be noted that the examples given are to indicate only the types of statements and do not follow through completely from Tables 2, 3, 4 and 5 to Table 6.

The next component of the Environmental Quality account is "B", archaeological, historical, biological and geological resources and selected ecological systems. As before, the beneficial and adverse effects from Table 3 are shown, and the difference column developed. The last two components of the Environmental Quality account are, "C", the quality of water, land and air resources, and "D", irreversible commitments of resources to future use. As before, the beneficial and adverse effects from Table 3 are appropriately entered for these two components.

Figures 3 and 4 are copies of two blank forms to use in developing these Summary Tables in a test case. One form should be used to compare the NED plan with the recommended plan and the other form should be used to compare the EQ Plan with the recommended plan. It is enough to make

Figure 3

Summary Table

Account	NED Plan	Recommended Plan	Difference (recommended plan minus NED Plan)
National Economic Development:			
Beneficial effects---------			
Adverse effects------------			
Net beneficial effects-----			
Environmental Quality:			
Beneficial and adverse effects:			
A. Open and green space, lakes:			
B. Archeological resources:			
C. The quality of water, land, and air resources:			
D. Irreversible commitments of resources to future use:			

Figure 4

Summary Table

Account	EQ Plan	Recommended Plan	Difference (recommended plan minus EQ Plan)
National Economic Development:			
Beneficial effects---------			
Adverse effects------------			
Net beneficial effects-----			
Environmental Quality:			
Beneficial and adverse effects:			
A. Open and green space, lakes:			
B. Archeological resources:			
C. The quality of water, land, and air resources:			
D. Irreversible commitments of resources to future use:			

these two comparisons and to demonstrate the process in this exercise. In real life, though, it will be necessary to develop data and summarize it for the Regional Development and Social Well-Being Accounts as shown on pages 128 through 139 of the Principles and Standards.

The regional development account comparisons are illustrated in Figure 5. Data would be taken from Table 4. To develop the comparisons in this table there are five components--A, B, C, D, and E.

In Figure 6, note that comparisons are shown for more than one region, when applicable, to utilize all the data developed in Table 4. The same components are shown for the other regions.

Figures 7 and 8 show, under the heading of "Rest of the Nation", the same components with values of more than regional importance.

For the last of the four accounts, Social Well-Being Comparisons are then developed in the same manner with data taken from Table 5 as shown in Figures 9 and 10.

Thus, the entire Table 6 showing comparisons under all four accounts is made for each significant alternative plan to show differences between it and the recommended plan. It may also be used to make other comparisons, if desired.

Figure 5

Table 6 Summary Comparison of Two Alternative Plans--Continued

	Plan B	Recommended Plan	Difference (recommended plan minus Plan B)
Regional Development:			
Region 1 - Components			
A. Income:			
Beneficial effects-----	$5,000,000	$6,800,000	+$1,800,000
Adverse effects--------	3,000,000	3,550,000	+550,000
Net beneficial effects-	2,000,000	3,250,000	+ 1,250,000
B. Employment:			
Beneficial effects:			
Project construction employment-----	1. 300 semiskilled jobs for 3 years.	1. 200 semiskilled jobs for 4 years.	1. 100 semiskilled jobs per year for 3 years, but +200 semiskilled jobs for 1 year.
Project O&M employment-------------------	2. 40 permanent semiskilled jobs.	2. 50 permanent semiskilled jobs.	2. +10 permanent semiskilled jobs.
Employment in service and trade activities induced by and stemming from project operation.	3. 850 permanent semiskilled jobs.	3. 900 permanent semiskilled jobs.	3. +50 permanent semiskilled jobs.
Adverse effects:			
Employment in activities induced by and stemming from displaced agricultural operations.	1. 15 permanent semiskilled jobs.	1. 50 permanent semiskilled jobs.	1. +35 permanent semiskilled jobs.
Net beneficial effects:	1. 300 semiskilled jobs for 3 years.	1. 200 semiskilled jobs for 4 years.	1. 100 semiskilled jobs per year for 3 years, but +200 semiskilled jobs for 1 year.
	2. 875 permanent semiskilled jobs.	2. 900 permanent semiskilled jobs.	2. +25 permanent semiskilled jobs.
C. Population Distribution:			

Figure 6

Table 6 Summary Comparison of Two Alternative Plans--Continued

Account	Plan B	Recommended Plan	Difference (recommended plan minus Plan B)
D. Regional economic base and stability: Beneficial and adverse effects by component evaluated in Table 4 would be compared for the differences between plans noted.			
E. Environmental conditions of special regional concern:			
Region 2 - Components			
A. Income:			
Beneficial effects-----	$2,500,000	$2,600,000	+$100,000
Adverse effects--------	2,600,000	2,950,000	+ 350,000
Net beneficial effects-	100,000	- 350,000	- 250,000
B. Employment:			
Beneficial effects:			
Project construction employment-----	1. 100 semiskilled jobs for 3 years.	1. 100 semiskilled jobs for 4 years.	1. Same number of semiskilled jobs per year for 3 years, but +100 semiskilled jobs for 1 year.
Project O&M employment-------------------	2.----------	2. 5 permanent semiskilled jobs.	2. +5 permanent semiskilled jobs.
Employment in service and trade activities induced by and stemming project operation.-----------------	3. 80 permanent semiskilled jobs.	3. 95 permanent semiskilled jobs.	3. +15 permanent semiskilled jobs.

Figure 7

Table 6 Summary Comparison of Two Alternative Plans--Continued

Account	Plan B	Recommended Plan	Difference (recommended plan minus Plan B)
Adverse effects:			
Employment in activities induced by and stemming from displaced agricultural operations----	1. 5 permanent semiskilled jobs.	-----------	1. -5 permanent semiskilled jobs.
Net beneficial effects-	1. 100 semiskilled jobs for 3 years.	1. 100 semiskilled jobs for 4 years.	1. Same number of semiskilled jobs per year, for 3 years, but +100 semiskilled jobs per year for 1 year.
	2. 75 permanent semiskilled jobs.	2. 100 permanent semiskilled jobs.	2. 25 permanent semiskilled jobs.
C. Population distribution:			
D. Regional economic base and stability:			
Beneficial and adverse effects by component evaluated in Table 4 would be compared for the alternative plans and differences between plans noted.			
E. Environmental conditions of special regional concern:			
Rest of Nation - Components			
A. Income:			
Beneficial effects-----	$ 500,000	-$1,400,000	-$ 900,000
Adverse effects--------	700,000	- 500,000	-1,200,000
Net beneficial effects-	-1,200,000	- 900,000	+ 300,000

Figure 8

Table 6 Summary Comparison of Two Alternative Plans--Continued

Account	Plan B	Recommended Plan	Difference (recommended plan minus Plan B)
B. Employment:			
Beneficial effects:			
Project construction employment	1. -300 semiskilled jobs for 3 years.	1. -200 semiskilled jobs for 4 years.	1. +100 semiskilled jobs for 3 years but -200 semiskilled jobs for 1 year.
Project O&M employment	2.-----------	2. -5 permanent semiskilled jobs.	2. -5 permanent semiskilled jobs.
Employment in service and trade activities induced by and stemming from project operation	3. -25 permanent semiskilled jobs.	3. -45 permanent semiskilled jobs.	3. -20 permanent semiskilled jobs.
Adverse effects:			
Employment in activities induced by and stemming from displaced agricultural operations	1. -15 permanent semiskilled jobs.	1. -50 permanent semiskilled jobs.	1. -35 permanent semiskilled jobs.
Net beneficial effects	1. -300 semiskilled jobs.	1. -200 semiskilled jobs for 4 years.	1. +100 semiskilled jobs for 3 years, but -200 semiskilled jobs for 1 year.
C. Population distribution:			
D. Regional economic base and stability: Beneficial and adverse effects by component evaluated in Table 4 would be compared for the alternative plans and differences between plans noted.			

Figure 9

Table 6 Summary Comparison of Two Alternative Plans--Continued

Account	Plan B	Recommended Plan	Difference (recommended plan minus Plan B)
E. Environmental conditions of special regional concern:			
Social Well-Being			
(Use same component stubs for beneficial and adverse effects as illustrated in Table 5. Examples follow.)			
Beneficial and Adverse effects:			
A. Real income distribution------------------	A. Plan is neutral in distribution of benefits by income class over first 20 years' operation with percentage distribution of benefits by income class the same as percentage distribution of adjusted gross income in class.	A. Plan has distribution of benefits by income class over first 20 years of operation as follows:	A. Increase distribution of real income to low income persons.

Following table is reflected under "Recommended Plan"

Income class (Dollars)	Percentage of adjusted gross income in class	Percentage benefits in class
Less than 3,000	11	22
3,000 - 10,000	62	64
More than 10,000	27	14

Figure 10

Table 6 Summary Comparison of Two Alternative Plans--Continued

Account	Plan B	Recommended Plan	Difference (recommended plan minus Plan B)
B. Life, health, and safety	B. Provide 100-year flood protection to city.	B. Provide 50-year flood protection to city.	B. Do not provide 100-year flood protection to city; provide 50-year flood protection to city.
C. Educational, cultural and recreational opportunities:	C. Create diversity of recreational opportunities by provision of (a) 7,500 man-days boating, (b) 4,000 man-days fishing, and (c) 20,000 man-days picnicking.	C. Create diversity of recreational opportunities by provision of (a) 10,000 man-days boating, (b) 5,000 man-days fishing, and (c) 20,000 man-days picnicking.	C. +2,500 man-days boating and +1,000 man-days fishing.
D. Emergency preparedness:	D. Plan would require using optimum sustained yield of groundwater resources to serve anticipated population over next 30 years with potential for overloading capacities of water resource systems.	D. Provide x kilowatts hydroelectric power generating capacity centrally located in region requiring importation of coal for conventional thermal plants.	D. Do not require use of optimum sustained yield of groundwater resources; provide x kilowatts hydroelectric power generating capacity.

"WINDUP"

Warren D. Fairchild
Director of the Water Resources Council
Washington, D.C.

Unfortunately for me, I was unable to attend the entire two week CSU/OWRT/WRC Training Seminar on the Principles and Standards. I know that I would have gained valuable information from the presentations and participation in the discussions. I look forward to reviewing the training material and your critique of the sessions.

As I attempted to get my thoughts together on my remarks for "winding up" this Seminar, I could not help but wonder as to what are your thoughts after "wrestling" these two weeks with this system. Are you confused, frustrated, enlightened, enthusiastic, motivated, at a point of physical and emotional exhaustion or all of the preceding? Won't it be nice to return to your office and again be associated with the known, the commonplace?

How we yearn to return to the simpler days of preparing a farm plan, design of a levee system for a town or the planting of a wildlife habitat area. It would be reassuring and satisfying to be able to give explicit and simple solutions to simple and singular problems. However, this is just not to be--this is not compatible with the times in which we are living. Most of all, if not all, the simple solutions have been implemented and, in most instances, have resulted in substantial economic returns. However, mamy seemingly simple answers (or plans) were given to what appeared to a simple problem, which in reality was a much more complex and not fully understandable situation. Many of the answers were not real answers, and some now compound an increasingly complex system. We are all aware of drainage projects intended to alleviate flooding but which resulted in additional downstream flooding and channel degradation.

We are living in a period of: critical competition for scarce resources; rapidly changing priorities and values; and international unrest. The energy crisis, population boom, worldwide drouth, global deterioration of the environment, demand for improved diet and standard of living, desire for more recreation and leisure time, improved technologies, quality of life are constantly "whip sawing" and confusing the planning and decision-making process. Secretary of the Interior Rogers C.B. Morton in presenting President Ford's first environmental statement last week said the Nation's economic problems may force the Nation to delay some environmental measures. Morton called energy and mineral development programs to be the top priority programs of the Department of the Interior. He stated there must be a balance between environment and economics.

The simple truth, if there is such a thing, is that the approaches to evaluating and formulating water projects and programs used heretofore were not geared to today's complexities. We cannot project that (X) is the water requirement for a certain function in a basin for the year 2020, 2000, or even 1990. It is impossible to state with certainty that reallocation, development, conservation, or augmentation is the proper consideration for a given situation; or whether a structural or nonstructural solution is the answer. The answer lies in what the affected public and decision makers perceive to be the solution or mix of solutions to a situation. I consciously use the word perceive. The perception can be based on emotion or fact. It is important that we as planners array viable alternatives based on our professional judgement and the best available facts and data. This is our input into rational decision making. If we do our job, more of the decisions in the natural resources field will be soundly based and not emotionally based. The Principles and Standards is the system that has been developed for this input.

Principles and Standards

Probably you did not find the system complete and without flaw. Is it possible that Henry Ford's first Model T came off the assembly line without some shortcomings? It is recognized that we have missing or weak links in the data bases, measurements, and procedures. However, do these deficiencies mean that we should junk the system? Look what happened to the Model T. What are the alternatives to this system?

I personally believe that the Principles and Standards as now approved are sound. This system based upon arraying monetary and non-monetary, impact in four accounts for minimum of two alternative plans, one NED and one EQ has sound logic. If a decision is made at a later date to increase the number of planning objectives, revise the discount rate, change the level of detail or insert new procedures, there is sufficient flexibility in the system to accommodate such changes. It is my position that the system is closer to what will evolve in the next 20 years than we have employed heretofore.

My request to those of you who have been privileged to participate in this session is to assist us in achieving additional perfection in the system. Hopefully, the discussions and testing in which you have participated these two weeks will be beneficial in arriving at needed improvements.

Presently, I have several major concerns that relate to the Principles and Standards. They are: (1) delays by action agencies, including WRC, in formalizing procedures for implementation; (2) need to employ appropriate judgmental planning to cut down costs associated with this relatively complex system; (3) training of decision makers in use of the system; (4) finding ways of facilitating the planning and review process; (5) adequately involving the public in developing the components of the objectives and the selection of alternatives; (6) achieving knowledge and acceptance - as to the rationality of the system.

On the last concern, we do have those individuals who are "poor mouthing" the Principles and Standards. Many negative points of view result from lack of knowledge and understanding. Some interest groups are concerned about the Principles and Standards because presentation of alternative plans may hurt their ability to accomplish their objectives. Also some individuals are still searching and hoping for the simple solution to a complex problem. I have found some individuals willing to assign all past ills of the planning program to the Principles and Standards--not recognizing that such ills predate the Principles and Standards.

You, the participants in this seminar, can be most helpful in several areas in the application of the Principles and Standards. These are: (1) perfecting the system; (2) training; (3) explaining the procedures; and (4) by example, evaluate and formulate viable alternative plans that make sense to the affected publics and serve as the basis of rational decision making.

Water Policy

At the close of my introductory remarks on August 12, 1974, I enumerated several issues on which I will dwell more fully on this, the last day of the training session. The first three issues noted (planning objectives, cost sharing, and discount rate) are to be reanalyzed in response to Section 80 of the 1974 Water Resources Development Act. The Congress has requested the President to conduct a one-year study of Principles and Standards for Planning and Evaluating Water and Related Land Resource projects, with particular emphasis on the above noted topics.

The lead responsibility for this study has not been assigned at this time.* I feel quite strongly that the Water Resources Council should be the lead agency, but regardless of the lead responsibility, the Water Resources Council will have a major input into such a study.

This is an extremely important activity. In this study the Executive Branch has an opportunity to cooperate with Congress in evolving a national water policy by integrating planning criteria, discount rate and cost sharing in a manner that could result in rational and pragmatic recommendations that could lead to meaningful dialogue and agreement between these two branches of Government. If this can be accomplished, we narrow the wide chasm that now exists between the Executive and Legislative Branches of Government on water policy. In recent discussion with Congressional staff members, I am convinced that Congress is extremely interested in this Section 80 study. There is interest in Congress in financing this study during F. Y. 1975 in order to implement this study at the earliest possible date.

---

* Subsequent to the delivery of this lecture, a letter from President Ford to Secretary of the Interior, Rogers C.B. Morton and Chairman of the Water Resources Council, dated 23 September, 1974 authorized the Water Council to conduct the one-year study of P&S for Planning and Evaluating Water and Related Land Resources projects.

Planning Objectives

The main thrust of Congress' concern relating to planning objectives is the failure to include regional development and social well-being as objectives in planning. The proposed rule making for the Principles and Standards as developed by a special task force called for four objectives: national economic development (NED), environmental quality (EQ), regional development (RD), and social well-being (SWB) and appropriate accounting for each. The finally approved Principles and Standards provide that plans will be formulated to meet the NED and EQ objectives only, with each objective receiving equal consideration. However, the effects of proposed plan and reasonable alternative will be evaluated and portrayed in four accounts--NED, EQ, RD, and SWB. The Members of the Council were reluctant to expand the Principles and Standards beyond two objectives because they questioned if water projects are the best instruments to secure regional development and also the reliability of measurements for "second round" effects.

If the Principles and Standards are eventually revised to include the RD and SWB objectives, most of what we have learned and discussed here will not be lost. The inclusion of the two new objectives would affect the planning methodology, but not the evaluation or accounting techniques. In effect, the planning process would generally be lengthened by the need to develop optimum plans for four objectives rather than two. Also, the use of four objectives would involve more consideration of possible trade-offs between objectives and, accordingly, a wider range of alternative plans. The evaluation and accounting techniques observed here during the seminar will not be altered by the possible addition of the RD and SWB objectives, but they will be used more frequently in each planning process. Federal agencies in testing the RD objectives found that employment of second round effects made it possible to economically justify and scope almost any size project. Consequently, some constraint is needed. It is my opinion that cost sharing, willingness to pay, could be such a constraint.

Cost Sharing

This issue has strongly reemerged as a result of the above-noted 1974 Water Resources Development Act. For my next few remarks, it should be understood that I am discussing cost sharing, not non-Federal financing --there is a difference. There are national interests and Federal benefits that justify a strong Federal role. Cost sharing is based on the concept of sharing of costs by all levels of government--Federal, State, and local--based on benefits received. Identification of benefits is part of the determination in the economic justification of projects. If you question the benefits, you are in essence questioning the justification of projects. It is my judgment that economically justified water projects are sound investments based on real benefits. If this is the case, then we need to evolve a method of financing so we can accrue these benefits. I have worked as a water professional at the local, State, and Federal level. I am convinced that benefits from these projects accrue at all of these levels. The question comes down as to how these levels can and should share cost in order that the construction of desirable projects can proceed in a rational and timely manner, which is not the case today. My conversations with many local and State officials lead me to believe that they stand ready to invest their funds in such projects--if the Federal Government articulates a sound water policy on cost sharing. These same people recognize the present program characterized by an indeterminate waiting period, because of the large backlog of authorized, but unconstructed water projects is not sound in that it does not allow for a reasonable, if any, assurance that a project will ever be constructed, at least in their life time. A combined estimated $20 billion worth of authorized but unconstructed projects are on the books for the Corps of Engineers, U.S. Bureau of Reclamation, and the U.S. Soil Conservation Service.

A pragmatic level of cost sharing will accomplish two things: (1) eliminate "free loaders" who are unwilling to pay for any of the benefits they will receive; and (2) increase funding for construction. However, a cost sharing policy, in order to be acceptable, must recognize an appropriate level of sharing of costs; and it must be at a level that encourages, not discourages, non-Federal cooperation. I see cost sharing as the real key in moving the Nation's water programs. I also recognize that cost sharing is always a "hot political potato" and particularly so in an election year.

Discount Rate

This issue has been around a long time and has been the source of much heated controversy. Congress, in Section 80 of the Water Resources Development Act of 1974, legislated a discount rate based on the 1968 WRC rule, which for Fiscal Year 1975 is 5-7/8 percent as compared to 6-7/8 percent in the Principles and Standards. It should be noted that if it were not for the limiting clause in the 1968 rule that the discount rate shall not increase or decrease more that 1/4 percent for any succeeding year, the discount rate for Fiscal Year 1975 would be 6-1/2 percent. Although the effects of different discount rates, as used in planning process, can be estimated fairly easily, other effects of the application of discount rates need to be known. As a general observation, advocates of high or low discount rate reflects the advocates' position of "pushing for" or "wanting to kill" water projects. It is my opinion that the use of a discount rate as the principal valve in turning on and off water projects is wrong. The discount rate must be considered with many other policy issues such as cost sharing and planning procedures in order to better achieve an appropriate national water program--and as I noted before, I consider cost sharing or the method of financing projects to be the real key.

Integration of Water Quality, Water Quantity, and Land Planning

Few planners will disagree with the concept that water quality, water quantity, and land planning should be coordinated and integrated. However, with institutional, legislative, administrative, and procedural restraints that are inherent and existing, the philosophical goal is often quite difficult to achieve. The Principles and Standards is a major effort to bring uniformity and integration into water and related land resources planning. However, the Principles and Standards do not cover all water and related land resources programs, particularly Federal grants. Generally, there is no fault in the concepts of the various grant programs. But, they are all too often administered under separate guidelines, separate Acts of Congress, by separate Federal institutions and, quite frequently, separate State agencies. The net result is that there is a very uncoordinated, uncooperative climate in which there appears to be polarization.

Congress recognized this problem and as a solution they included Section 209 in the 1972 Amendments to the Federal Water Pollution Control Act. This section calls for the President through the U.S. Water Resources Council to complete by 1980 Level B plans for all river basins and the U.S. Congress authorized $200,000,000 for this purpose. A special State-Federal task force developed a new approach to Level B planning specifically geared to Section 209 and the integration of water quality, water quantity, and land planning. We are presently testing this approach. The Governors of States and regional organizations have responded to this approach by submitting 20 applications for Level B plans to be considered during Fiscal Year 1976.

The U.S. Water Resources Council is scheduled to complete the Level B procedures this calendar year.

Coordination of Level C Planning Recognizing Priorities of Needs and Relationships to Completed Comprehensive Plans.

The Principles and Standards cover the coordination and review of implementation studies. However, every effort should be made to bring common sense into Level C planning, particularly for areas that are included in completed comprehensive plans. Priorities need to be established to reflect the critical nature of problems that need alleviation. Also, to be considered is the dependency or independency of the projects and programs included in the overall complete comprehensive plan. The need to phase in the separate components of a plan to most effectively and efficiently achieve plan objectives is the key to good plan implementation. The Water Resources Council plans to develop procedures for coordinating Level C plans compatible with completed comps. The Council must be aggressive in supporting Level C plans that are in this category.

Inventorying and Quantification of Reserved, Appropriative and Other Federal Water Rights

To adequately plan for water resources development and review of the status of and possible legislative recommendations relating to Federal water rights is necessary. This matter is particularly sensitive in the Western States because of large Federal holdings and existing State water laws on appropriate rights.

The Council has been working closely with the Department of Justice to develop possible alternatives to the National Water Commission's legislative recommendations regarding United States reserved and other rights to the use of water. Justice has submitted such an alternative for Council consideration. The Interstate Conference on Water Problems has agreed to use its facilities in transmitting this material to appropriate State officials for review and comment.

This is an extremely controversial issue. However, successful enactment of legislation in this area would overcome the present unknown from State water right holders as to the ultimate fate of yet to be determined Federal water rights.

Institutions

What institutional arrangement or arrangements can best utilize the Principles and Standards or other procedures and guidelines in furthering the planning for and development of the Nation's water and related land resources? The present institutional complex ranges from the Federal role (e.g., the possible establishment of a Federal Department of Natural Resources) to institutional arrangements for subdivisions of State government. At issue is, should the current organizational arrangements of such agencies as the WRC, river basin commissions established under Title II of the Water Resources Planning Act, Federal regional councils, Federal natural resources regional councils, Federal-State compact commissions, interstate compacts, Federal interagency committees, Federal-State interagency committees, etc., be strengthened, enlarged, eliminated, combined, or in some other way, modified? Needing resolution are answers relating to the selection of preferred organizational arrangements for the various jurisdictional combinations including necessary legal authority. The Federal Government is not alone with the problem of proliferation of authority and responsibility in the natural resources field. Much needs to be done at the State and local levels. One of the dark and unknown areas of government is at the local area where there is a maze of uncoordinated, duplicating special purpose resource districts. This affliction of "districtitis" has been responsible to a great extent for much of the confusion and lack of progress in the water field.

Summary

When I came with the Water Resources Council one year ago, I indicated that in my opinion water policy appeared, to me, to afford the best opportunity for positive progress in the near future in the water resources field. I am further encouraged by the action of Congress in enacting the Section 80 Study. I am most hopeful that the Administration will soon assign leadership so that this important study can be implemented in the near future.

I want to thank you, the participants, in this Seminar for giving your time in this training exercise. I trust that this program proved to be worthwhile and of value to you. I also want to thank Colorado State University, Henry Caufield, Director of the Seminar, and all of the instructors for their professional input to this endeavor. And lastly, I want to express my appreciation to the Office of Water Resources Research and Technology for financing this activity. This seminar has served a valuable requirement of achieving a level of uniformity in training in the implementation of the Principles and Standards. Training material evolving from this session in form of manuals and T.V. materials will further facilitate such training. However, it is my analysis that you the participants are a key to further training and implementation.

As I indicated earlier in this presentation, there are four areas in which participants can be helpful in implementing the Principles and Standards. These are: (1) perfecting the system; (2) training; (3) explaining the procedure; and (4) by example, evaluate and formulate viable alternative plans that make sense to the affected publics and serve as the basis for rational decision making.

In returning to your respective offices, I wish you the best professionally. You as natural resources planners represent a proud profession. The challenge which face us has never been greater. Properly implemented, the Principles and Standards can be a valuable tool in meeting this challenge.

Appendix 1

Video Tape Cassettes Available for Training in the Application of Principles and Standards of the Water Resources Council

Broad Topic Groupings	WRC Cassette No.	Subject Title	Author/Lecturer	Cassette Time Min:Sec.
I Overview	WRC-1	Overview of Principles and Standards	Warren D. Fairchild, Water Resources Council	28:10
	WRC-2	Planning Process and Its Institutional Setting	Gary D. Cobb, Water Resources Council	33:11
II Objectives	WRC-3	National Economic Development (NED) Objective	Robert A. Young, Colorado State University	30:00
	WRC-4	Environmental Quality (EQ) Objective	Ervin H. Zube, University of Massachusetts	28:30
	WRC-5	Regional Development (RD) and Social Well-Being (SWB)	Robert M. Gidez, INTASA Consultants, Alexandria, VA	27:20
	WRC-6	Economic Projections	Henry L. DeGraff, Bur. Econ. Analysis, U.S.D.C. William A. Green, Econ. Research Service, U.S.D.A.	26:40
III Projections	WRC-7	Environmental Projections and Carrying Capacity Models	A. Bruce Bishop, Utah State University	33:30
IV Measurement	WRC-8	Measurement of NED Effects	Robert A. Young, Colorado State University	27:50
	WRC-9	Measurement of EQ Effects (Part A)	Gary L. Hickman, Fish & Wildlife Serv., Dept. of Int.	19:10
	WRC-10	Measurement of EQ Effects (Part B)	Gary L. Hickman, Fish & Wildlife Serv., Dept. of Int.	38:44
	WRC-11	a) Overall Issues and Methods of Measurement	Dirk P. Lijesen, INTASA Consultants, Menlo Park, CA and	35:24
		b) Economic Models for the Measurement of Regional Income and Employment Effects	Henry L. DeGraff, Bur. Econ. Analysis, U.S.D.C.	
	WRC-12	Measurement of SWB Effects	Dirk P. Lijesen, INTASA Consultants, Menlo Park, CA	36:00
V Systems Analysis	WRC-13	Application of Systems Analysis to the Planning Process	John W. Labadie, Colorado State University	33:15
	WRC-14	System of Accounts and Cost Allocation	Gary D. Cobb, Water Resources Council	21:58
	WRC-15	River Basin Simulation for Planning	Robert W. Hill, Utah State University	38:10
VI Public Participation	WRC-16	Analysis of Tradeoffs	John E. Keith, Utah State University	21:00
	WRC-17	Determination of Political Feasibility	James Mulder, Utah State University	35:40
	WRC-18	Public Participation	Ann Widditsch, Public Affairs Consult., Seattle, WA	21:00
	WRC-19	Public Decisionmaking Processess	Henry P. Caulfield, Jr., Colorado State University	18:56
VII Plan Formulation	WRC-20	Step 1-Specification of Components of NED and EQ Objectives	Leonard T. Crook, Great Lakes Basin Commission	21:15
	WRC-21	Step 2-Evaluation of Resources Determination	George H. Walen, U.S. Bureau of Reclamation	17:00
	WRC-22	Step 3-Develop Alternative Plans	Don Jones, Soil Conservation Service, U.S.D.A.	23:00
	WRC-23	Steps 4 and 5-Comparison of Alternative	Don Jones, Soil Conservation Service, U.S.D.A.	7:55
	WRC-24	Step 6-Selection of a Recommended Plan	Emil W. Adam, Corps of Engineers, San Francisco	27:20
VIII Conclusions	WRC-25	"Windup"	Warren D. Fairchild, Water Resources Council	34:11

The statements made in each video-tape presentation are those of the lecturer. It is possible the views of the Water Resources Council (WRC) may not always be reflected; however, every effort has been made to avoid discrepancies.

Appendix 2

Instructors/Leaders

Adam, Emil W.
Chief Plan Formulation Branch
South Pacific Division,
Corps of Engineers
630 Sansome Street, Rm. 1212
San Francisco, California 94111

Bishop, A. Bruce
Civil and Environmental
Engineering
Utah State University
Logan, Utah 84322

Caulfield, Henry P., Jr.
Department of Political Science
Colorado State University
Fort Collins, Colorado 80523

Cobb, Gary D.
Assistant Director
U.S. Water Resources Council
2120 L Street, N.W.
Washington, D.C. 20037

Crook, Leonard T.
Executive Director
Great Lakes Basin Commission
P.O. Box 999
Ann Arbor, Michigan 48106

DeGraff, Henry L.
Assistant Chief
Regional Economic Analysis Division
Bureau of Economic Analysis
U.S. Department of Commerce
1401 "K" Street, N.W.
Washington, D.C. 20230

Fairchild, Warren D.
Director
Water Resources Council
2120 L Street, N.W.
Washington, D.C. 20037

Gidez, Robert
(formerly an economist with
Corps of Engineers)
Vice President, Program Development
INTASA, Consultants
421 King Street
Alexandria, Virginia 22314

Green, William A.
Assistant Director for Water
Planning Activities
Natural Resources Economics Division
Economic Research Service
U.S. Department of Agriculture
Washington, D.C. 20250

Hickman, Gary L.
U.S. Water Resources Council
2120 L Street, N.W.
Washington, D.C. 20037

Hill, Robert W.
Department of Agricultural and
Irrigation Engineering
Utah State University
Logan, Utah 84322

Jones, Don
Economist
Soil Conservation Service
Department of Agriculture
Washington, D.C. 20050

Keith, John E.
Utah Water Research Laboratory/
Department of Economics
Utah State University
Logan, Utah 84322

Labadie, John W.
Water Resource Systems Program
Department of Civil Engineering
Colorado State University
Fort Collins, Colorado 80523

Mulder, Jim
Department of Political Science
Utah State University
Logan, Utah 84322

Wallen, George H.
Environmental Specialist
U.S. Bureau of Reclamation, E&R Center
Building 67, Denver Federal Center
Code 730
Denver, Colorado 80225

Widditsch, Ann
Consultant in Public Affairs
501 West Olympic Place
Seattle, Washington 98819

Young, Robert A.
Department of Economics
Colorado State University
Fort Collins, Colorado 80523

Zube, Ervin H.
Director
Institute for Man and Environment
Blaisdell House
University of Massachusetts
Amherst, Massachusetts 01002

COMPLETION REPORT SERIES
(Available from the Center at price shown)

No.	Title	Date	Price
1.	Bacterial Response to the Soil Environment	6/69	5.00
2.	Computer Simulation of Waste Transport in Groundwater Aquifers	6/69	5.00
3.	Snow Accumulation in Relation to Forest Canopy	6/69	5.00
4.	Runoff From Forest and Agricultural Watersheds	6/69	3.00
5.	Soil Movement in an Alpine Area	6/69	5.00
6.	Stabilization of Alluvial Channels	6/69	3.00
7.	Stability of Slopes with Seepage	6/69	3.00
8.	Improving Efficiency in Agricultural Water Use	6/69	5.00
9.	Controlled Accumulation of Blowing Snow	6/69	5.00
10.	Economics and Administration of Water Resources	6/69	5.00
11.	Organizational Adaptation to Change in Public Objectives for water Management of Cache La Poudre River System	6/69	3.00
12.	Economics and Administration of Water Resources	6/69	5.00
13.	Economics of Ground Water Development in the High Plains of Colorado	6/69	5.00
14.	Hydrogeology and Water Quality Studies in the Cache La Poudre Basin, Colorado	6/69	5.00
15.	Hydraulic Operating Characteristics of Low Gradient Border Checks in the Management of Irrigation Water	6/68	3.00
16.	Experimental Investigation of Small Watershed Floods	6/68	5.00
17.	An Exploration of Components Affecting and Limiting Policymaking Options in Local Water Agencies	11/68	5.00
18.	Experimental Investigation of Small Watershed Floods	6/70	5.00
19.	Hydraulics of Low Gradient Border Irrigation Systems	6/70	3.00
20.	Improving Efficiency in Agricultural Water Use	7/70	3.00
21.	Waterfowl-Water Temperature Relations in Winter	6/70	5.00
22.	An Exploration of Components Affecting and Limiting Policymaking Options in Local Water Agencies	6/70	3.00
23.	A Systematic Treatment of the Problem of Infiltration	6/71	3.00
24.	Studies of the Atmospheric Water Balance	8/71	5.00
25.	Evaporation of Water as Related to Wind Barriers	6/71	5.00
26.	Water Temperature as a Quality Factor in the Use of Streams and Reservoirs	12/71	5.00
27.	Local Water Agencies, Communication Patterns, and the Planning Process	9/71	5.00
28.	Combined Cooling and Bio-Treatment of Beet Sugar Factory Condenser Water Effluent	6/71	5.00
29.	Identification of Urban Watershed Units Using Remote Multispectral Sensing	6/71	5.00
30	Geohydraulics at the Uncomformity Between Bedrock and Alluvial Aquifers	6/72	5.00
31.	Sedimentation and Contaminant Criteria for Watershed Planning and Management	6/72	5.00
32.	Bacterial Movement Through Fractured Bedrock	7/72	5.00
33.	The Mechanism of Waste Treatment at Low Temperature, Part A: Microbiology	8/72	5.00
34.	The Mechanism of Waste Treatment at Low Temperature, Part B: Sanitary Engineering	8/72	5.00
35.	An Application of Multi-Variate Analysis in Hydrology	8/72	5.00
36.	Urban-Metropolitan Institutions for Water Planning Development and Management	9/72	5.00
37.	Searching the Social Science Literature on Water: A Guide to Selected Information Storage and Retrieval Systems - Preliminary Version	9/72	5.00
38.	Water Quality Management Decisions in Colorado	6/72	5.00
39.	Institutions for Urban-Metropolitan Water Management Essays in Social Theory	11/72	5.00
40.	Selection of Test Variable for Minimal Time Detection of Basin Response to Natural or Induced Changes	12/72	5.00
41.	Ground Water Recharge as Affected by Surface Vegetation and Management	12/72	5.00
42.	Theory and Experiments in the Prediction of Small Watershed Response	12/72	5.00
43.	Experiments in Small Watershed Response	12/72	5.00
44.	Economic, Political, and Legal Aspects of Colorado Water Law	2/73	5.00
45.	Mathematical Modeling of Water Management Strategies in Urbanizing River Basins	6/73	7.50
46.	Evaluation or Urban Water Management Policies in the Denver Metropolitan Area	6/73	7.50
47.	Coordination of Agricultural and Urban Water Quality Management in the Utah Lake Drainage Area	6/73	7.50
48.	Institutional Requirements for Optimal Water Quality Management in Arid Urban Areas	6/73	3.00
49.	Improvements in Moving Sprinkler Irrigation Systems for Conservation of Water	6/73	7.50
50.	Systematic Treatment of Infiltration with Applications	6/73	5.00
51.	An Experimental Study of Soil Water Flow Systems Involving Hysteresis	8/73	7.00
52.	Consolidation of Irrigation Systems: Phase I-Engineering, Legal, and Sociological Constraints and/or Facilitators	6/73	25.00
53.	Systematic Design of Legal Regulations for Optimal Surface-Groundwater Usage	8/73	7.00
54.	Geologic Factors in the Evaluation of Water Pollution Potential at Mountain Dwelling Sites	12/73	10.00
55.	Water Law in Relation to Environmental Quality	3/74	30.00
56.	Evaluation and Implementation of Urban Drainage and Flood Control Projects	6/74	8.00
57.	Snow-Air Interactions and Management of Mountain Watershed Snowpack	6/74	3.00
58.	Primary Data on Economic Activity and Water Use in Prototype Oil Shale Development Areas of Colorado: An Initial Inquiry	6/74	2.00
59.	A System for Geologic Evaluation of Pollution at Mountain Dwelling Sites	1/75	3.50

COMPLETION REPORT SERIES
(Available from the Center at price shown)

No.	Title	Date	Price
60.	Research Needs as Related to the Development of Sediment Standards in Rivers	3/75	3.00
61.	Economic and Institutional Analysis of Colorado Water Quality Management	3/75	5.00
62.	Feasibility and Potential of Enhancing Water Recreation Opportunities on High Country Reservoirs	6/75	4.00
63.	Analysis of Colorado Precipitation	6/75	2.00
64.	Computer Estimates of Natural Recharge from Soil Moisture Data-High Plains of Colorado		
65.	Urban Drainage and Flood Control Projects: Economic, Legal and Financial Aspects	7/75	10.00
66.	Individual Home Wastewater Characterization and Treatment	7/75	8.00
67.	Tosic Heavy Metals in Groundwater of a Portion of the Front Range Mineral Belt	6/75	3.00

INFORMATION SERIES

1.	Inventory of Environmental Resources Research in Progress - Colorado State Univ.	1/71	Free
2.	Economics of Water Quality--Salinity Pollution-Abridged Bibliography	6/71	11.00
3.	Inventory of Environmental Resources Research in Progress - Colorado State Univ.	7/72	Free
4.	Proceedings Workshop on Home Sewage Disposal in Colorado	6/72	Free
5.	Directory of Environmental Research Faculty - Colorado State Univ.	12/72	Free
6.	Water Law and Its Relationship to Environmental Quality: Bibliography of Source Material	1/73	7.00
7.	Wildlife and the Environment, Proc. of Governor's Conference, March 1973	3/73	3.00
8.	Inventory of Current Water Resources Research at Colorado State Univ.	7/73	Free
9.	Proceedings of the Symposium on Land Treatment and Secondary Effluent	11/73	3.00
10.	Proceedings of a Workshop on Revegetation of High-Altitude Disturbed Lands	7/74	3.00
11.	Surface Rehabilitation of Land Disturbances Resulting from Oil Shale Development	6/74	Free
12.	Water Quality Control and Administration Laws and Regulations	74	10.00
13.	Flood Plain Management of the Cache La Poudre River Near Fort Collins	8/74	2.75
14.	Bibliography Pertinent to Disturbance and Rehabilitation of Alpine and Subalpine Lands in the Southern Rocky Mountains	2/75	Free
15.	Proceedings of the Symposium on Water Policies on U.S. Irrigated Agriculture: Are Increased Acreages Needed to Meet Domestic or World Needs?	3/75	4.00
16.	Annotated Bibliography on Trickle Irrigation	6/75	Free

TECHNICAL REPORTS

1.	Surface Rehabilitation of Land Disturbances Resulting from Oil Shale Development	6/74	10.00
2.	Estimated Average Annual Water Balance for Piceance and Yellow Creek Watersheds	8/74	Free
3.	Implementation of the Federal Water Project Recreation Act in Colorado	6/74	Free
4.	Vegetative Stabilization of Spent Oil Shales	12/74	3.00
5.	Revegetation of Disturbed Surface Soils in Various Vegetation Ecosystems of the Piceance Basin	12/74	4.25
6.	Colorado Environmental Data Systems (abridged)	10/72	5.00

For purchases totalling less than $5.00 enclose remittance with order.